Row:

The Bus Designed with the Driver in Mind

Jenny Feng

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Research Thesis

In partial fulfillment of the requirements for graduation with research distinction in Industrial Design in the undergraduate colleges of The Ohio State University

by

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May 2021

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ABSTRACT

Amidst the COVID-19 pandemic, public transit bus drivers put their lives on the line to provide the essential service of transportation. Bus drivers risk contracting COVID-19, at the same time, cases of violence towards drivers have increased. Even before the pandemic, bus drivers have been experiencing both verbal and physical assaults from irate and intoxicated passengers. These assaults are often due to fare disputes; however, bus delays and racial tensions are also contributing factors for passenger rage. Despite these issues, many bus drivers still value interacting with passengers.

Row, a concept electric bus designed with the driver in mind, aims to address these issues that bus drivers face. Row features a separate driver cabin made achievable by switching the location of the front wheels and front door of a bus. This separate cabin protects drivers from interactions with potential COVID-19 positive passengers and irate passengers. Drivers will no longer facilitate fare payment, thus preventing fare disputes. Fare payment is made convenient and accessible to passengers at kiosks at bus stops and convenience stores. Passenger can also pay their fare and speak to the driver through the Row website. Drivers can open the cabin door or the cabin window to allow for socially distanced conversations. The layout of the bus increases passenger seating and permits them to sit closer to the driver cabin to allow for interaction. Row acts to protect drivers from COVID-19 and prevent violence from passengers, without eliminating all passenger and driver interactions.

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0. INTRODUCTION

Covid-19 lockdowns in the U.S. began in March. This was when it became apparent to most that the coronavirus was no joke. Many things have changed since then for better or for worse. Work and school from home became the norm. More companies realized that working from home is quite advantageous. But the fear of worsening mental health in all populations, rise in domestic abuse, loss of jobs, etc. still gloomed over us.

Many people lost their jobs. Many people were furloughed. Some would say the lucky ones were the people who could work from home. Then there is the group of people who could not work from home because society depended on them. These are who we now call essential workers. They are grocery workers, sanitation workers, transportation workers, healthcare workers, etc. Excluding healthcare workers, all of these people are extremely unappreciated. It took a pandemic for everyone to see that society is held up by the hands of these people. Yet, many of them are still underpaid and lack benefits.

Among these essential workers are the transportation workers. They provide everyone with the essential service of transportation. When people stayed home, transportation workers kept working because other essential workers and people still needed transportation. The occupation group of transportation and material moving experienced the most injuries and illnesses out of all occupation groups in 2018 (U.S. Bureau of Labor Statistics). These injuries and illnesses are due to transportation incidents, falls, violence from passengers, etc. With the COVID-19 pandemic, the issue of contracting COVID-19 only adds to the illnesses that these workers will experience. Many transportation workers that recover from COVID-19 need to return to work immediately because they depend on their job and society depends on them.

Another thing that COVID-19 did was unveil the true colors of many people. People who refuse to wear masks because they think COVID-19 is a hoax. People who attack Asians because this is the “China Virus.” Bus drivers specially have been the target of violence because people refuse to wear masks when drivers ask them to. A French bus driver was killed trying to enforce the mask rule. A San Francisco bus driver was assaulted because as he attempted to enforce the mask rule. The offenders attacked him and claimed that he was the reason for COVID.

Narrowing it down to bus drivers alone, we find that they are an overlooked group. Even without COVID-19, bus drivers experience both physical and verbal abuse from irate passengers due to several reasons. Fare disputes are the most common cause for a passenger to lash out. Then there are also unruly passengers who may be intoxicated or just looking to release their anger on someone.

Along with the violence, bus drivers suffer from work resulted health issues.

Bus drivers operate the bus in 8-hour long shifts. This sedentary lifestyle alone causes many health issues, but there is also the risk of getting whole body vibration syndrome. This is where the driver’s skeletal system is being shaken up due to long hours of constant vibrations from the harshness of the road. This causes chronic back and leg pain.

There are so many problems that bus drivers must face as they are operating such a large and difficult to maneuver vehicle. Even being cramped in an uncomfortable cube for 8-hours can be a pain. As transit agencies attempt to install barriers to prevent violent attacks and protect the bus driver, these barriers put the driver in a cage.

With all of these issues something must be done for our bus drivers. As they are respectable people in our community, who work to empower us all and they play a part in the success in all of our lives. We should do something and it is worth designed for them and putting them first.

Therefore, I introduce Row, a concept electric bus that puts the driver first. It is designed to protect bus drivers without eliminating interactions with passengers. However, just because Row puts the drivers first does not mean the passengers are neglected. The main duty of a bus is to transport passengers safely, Row does that and protects the drivers. Row is the next fleet of buses that wants to work towards a future where bus driver injuries and illnesses decrease.

1. BACKGROUND

OVERVIEW

This first chapter consists of my preliminary research. Here I will present the problematic, which will provide an overview of problem space. This preliminary research acted as an exploratory way of helping me identify the main problems relating to my topic of interest, which revolved around **supporting transportation workers.**

This preliminary research consisted of collecting information on the topic of transportation and essential workers through reviewing articles. These articles served to broaden the scope of the problem space and allowed me to gain insight on the issues that transportation workers are facing during the COVID-19 pandemic and pre-COVID. I gathered different articles that fell under the topics of *Focus, Business, Art, and Science & Technology.* After gathering information from these articles, I mocked up design conjectures that were meant to further explore the problem space. I also conducted a survey that examined the safety concerns of transportation workers.

Preliminary Research:

Focus

In the focus section, I intended to look for information on how essential workers we dealing with the COVID-19 pandemic. I wanted to hear about what issues different essential workers, from sanitation, transportation, grocery, etc., are facing. All of these articles included experiences from transportation workers because that was my group of interest, but learning about how other essential workers were coping was insightful. This section really set up my understanding of the problem space for most essential workers

'It's constant verbal abuse': San Francisco bus driver recounts assault after...

Jenny Feng - September 3, 2020 0

'We're risking our life': coronavirus takes a toll on essential workers...

Jenny Feng - September 3, 2020 0

A Transit Worker's Survival Story

Jenny Feng - September 3, 2020 0

The pandemic changed our definition of 'essential.' Will we act on...

Jenny Feng - September 3, 2020 0

'We Are Not Essential. We Are Sacrificial.'

Jenny Feng - September 3, 2020 0

WHAT I LEARNED:

- Transportation workers experience verbal and physical violence due to racial tensions, angry passengers, etc.
- There has been a rise in Anti-Asian Sentiment as a result of COVID-19, which has prompted violence towards Asian essential workers.
- There is a lack of support for essential workers, as companies are slow to provide necessary PPE, sanitation resources, and better work conditions.
- Workers who have gotten COVID often return immediately because they depend on their job, which often tends to be low paying and lacking of benefits.
- Essential workers obviously face the issue of contracting COVID-19.
- Transportation workers, especially bus drivers, experience whole body vibration syndrome, which leads to chronic body pain, due to the long hours of feeling vibrations and bumps while driving and the sedentary nature of the job.
- Enforcing COVID rules can lead to customer or passenger rage, which results in violences towards the worker.

Preliminary Research:

Art

In the art section, I intended to see what people have been creating for essential workers during the pandemic or if essential workers have been making any art. This section showed how the community has pitched in to highlight and appreciate our essential workers. I think this section best reveals that essential workers, previously known as service workers, were so overlooked. Now everyone understands the significance of these people and are grateful for them.

'Riding up Front' art group features immigration stories of Uber, Lyft...

Jenny Feng - September 8, 2020 0

By Tatiana Sanchez There's the story of Muhammad, the Pakistani driver who wants his 7-year-old daughter to become a...

Art starts at bus stops

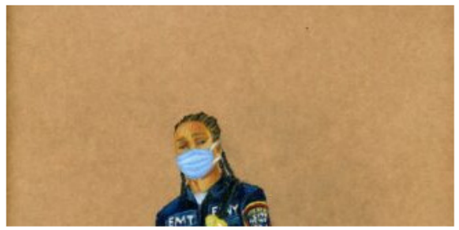
Jenny Feng - September 8, 2020 0

By Michael Kelley PORTLAND — Bus shelters in Portland have become a new canvas for public art.

Google Is Using Its Doodle Art Series to Salute Workers on...

Jenny Feng - September 8, 2020 0

By Sarah Cascone You may have noticed a theme for the daily Google Doodles of the past two weeks: each one...



How a Brooklyn Artist Is Making Black Women Her Focus

Jenny Feng - September 8, 2020 0

By Sandra E. Garcia The faces of the women in her portraits are often partly covered by a mask...

Portraits of Essential California Workers

Jenny Feng - September 8, 2020 0

By Aashna Malpani, Deena Sabry and Stephanie Penn Today we have a dispatch from students at the University of California, Berkeley, Graduate School...

WHAT I LEARNED:

- Art is important and meaningful. Art can show everyone the realities of being an essential worker.
- Artists during the onset of the pandemic, wanted to create art that portrayed essential worker to be heroes that they are. They are heroes that we see everyday and often forget, so we must be grateful for the services they provide and their efforts to keep society running.
- Often times the essential workers you see are Black, Indigenous, People of Color. They deserve a voice and appreciate for what they do and who they are.
- From local artists to big companies, they are creating art, signage, and even statements to show their appreciation and to remind us to be thankful.
- Essential workers play such a huge part in everyone of our lives.

Preliminary Research:

Business

In the business section, I discovered existing business models that lie within the realm of transportation, ranging from ride hailing to ride sharing, and from efficient fare collection to no contact delivery. This section provided insight on what business models were and were not successful, as well as, a look into the future and how business models will have to adapt to the future and life after COVID-19.

Lyft and Uber lure people with low fares, but how long...

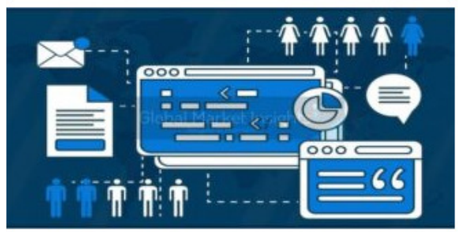
Jenny Feng - September 15, 2020 **0**

Israel's 'smart commuting' shows what public transport could be like after...

Jenny Feng - September 15, 2020 **0**

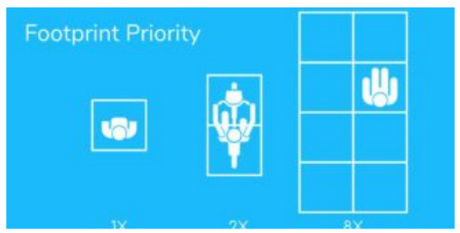
Amazon unveils a new Prime Air drone it says 'within months'...

Jenny Feng - September 15, 2020 **0**



Automated Fare Collection System Market Expected to Witness a Sustainable Growth...

Jenny Feng - September 15, 2020 **0**



Transportation Business Models Are Broken. It's Time To Fix Them

Jenny Feng - September 14, 2020 **0**

WHAT I LEARNED:

- Projection of transportation leaning to more ride sharing business models and increased use of public transportation.
- There are three types of mobility business models: own, ride, and rent. Own, which tends to be the more expensive option that creates more traffic congestion. Ride, which is convenient and someone will drive you around, but still adds to congestion. Lastly, rent, which allows you to temporary use a transportation device with a fee. Resulting less of a need for people to own their own vehicles.
- There is also the share, which is where you can share a vehicle with multiple people overall deceasing congestion and being better for the environment. Public transportation works as the share business model.
- Growth of E-commerce has led to more deliveries and there are ways of conducting contactless deliveries through drones and automated vehicles.
- Automated fare systems speed up the process and are more contact free.
- COVID-19 has cause a surge back to using private vehicles and relying less on shared vehicles, but it is projected to change post-COVID.

Preliminary Research:

Science & Technology

In the science & technology section, I intended to research different technologies that related to the services that essential workers provide. I found out that a lot of the technologies being used act to replace the worker, however, there is always someone overseeing these technologies or controlling them. This section provided me with the knowledge of existing technologies and the advantages of using them. This section allowed for a glimpse at what is possible and how people still are necessary despite autonomous technologies.

About Sydney Metro

Jenny Feng - September 11, 2020 0

Augmented Reality HUDs Will Make Vehicles Safer, But There's a Catch

Jenny Feng - September 10, 2020 0

Meet the Robots Working Side-by-Side Essential Healthcare Workers

Jenny Feng - September 10, 2020 0

'This is our future': Fairfax tests region's first self-driving shuttle for...

Jenny Feng - September 10, 2020 0

Japanese convenience stores will use VR-controlled robots to stack shelves

Jenny Feng - September 10, 2020 0

WHAT I LEARNED:

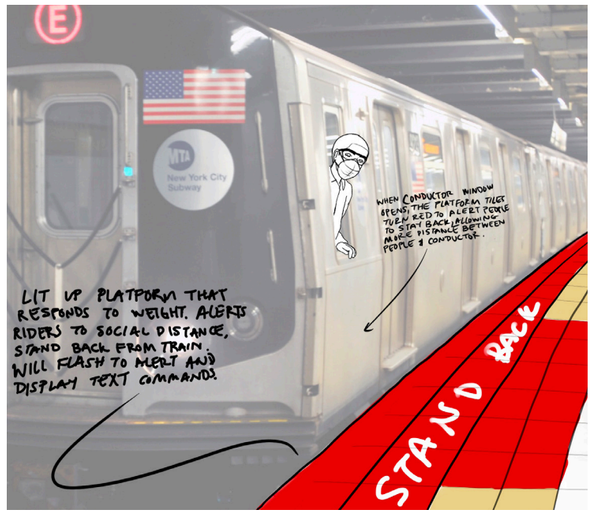
- A future working towards autonomous vehicles and robots providing services is very real. However they cannot replace essential workers. As there needs to be workers to regulate and oversee actions.
- Working alongside robots is advantageous as they can prevent the spread of COVID-19, but still allow workers to interact with patients in the hospitals.
- Developing efficient transportation that is intuitive and well integrated throughout all sort of locations, improves the travel experience.
- Fully automated transit systems work best for rail transit since it sits on the rails without needing to worry about other vehicles, and unexpected traffic conditions.
- Heads up displays with AR technology may aid the driver in navigation and understanding road circumstances, but poses as potential distractions. Must design these interfaces carefully by considering information density to prevent information overload.

Preliminary Research:

Design Conjectures

These conjectures acts as another form of research, initial concepts, and fun explorations that show what to do and what not to do.

Focus: Safety Strip

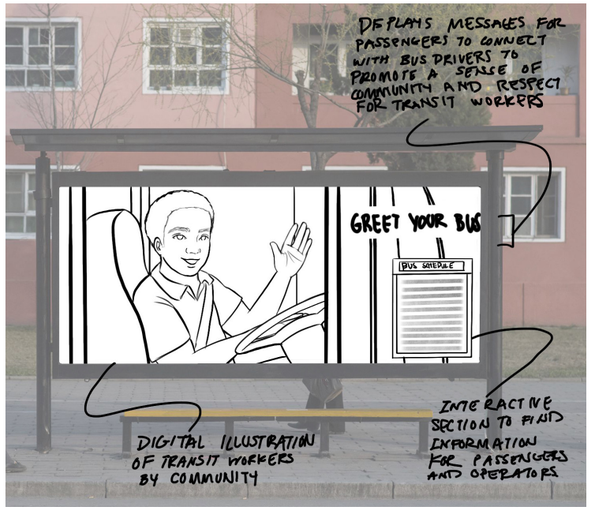


A platform triggered by body weight that alerts passengers to keep distance from operators, moving trains, and other passengers. The idea behind this conjecture was to enforce social distancing and limit operator to passenger interactions.

WHAT I LEARNED

- Crowding in transit station is inevitable, so I would need to develop more of a system that will decrease crowding, but still allow for quick and efficient loading of the subway.

Art: Meet Me Mural



An interactive display aimed to promote a sense of community and respect for bus drivers. This display would show community illustrated portraits of bus drivers with positive and helpful messages to engage a sense of community and respect.

WHAT I LEARNED

- Art can engage people allow them to be more empathetic, which can help resolve anger.
-

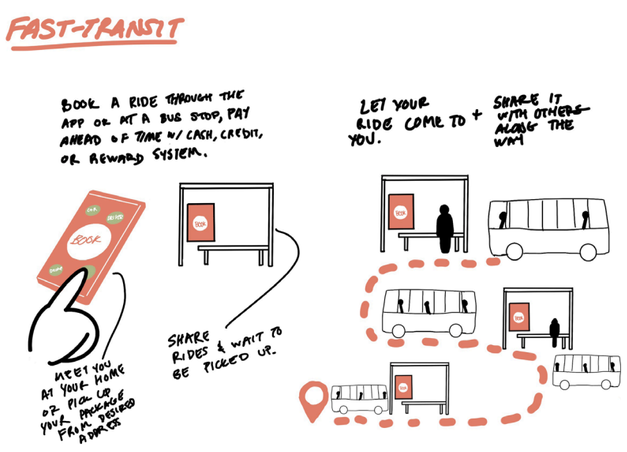
Technology: Kind Glass

A pair of AR glasses with bone conduction technology that alters a negative interaction into a positive one. Thus creating the “perfect” driving experience where all interactions with passengers were manipulated to appear positive.

WHAT I LEARNED

- Fun to develop a Utopian product, but this creates more problems because reality is being distorted.
- AR technology is not fully developed and is expensive.

Business: Fast-Transit



A people’s and materials transit service that eliminates peer-to-peer transactions with online payment by credit or rewards system. It limits operator passenger interaction and continues to promote more shared transportation experiences post-COVID

WHAT I LEARNED

- A service that can transport people and materials may be convenient, but still may be a problem during COVID, as it is marketed as a shared mobility service

Preliminary Research:

Survey & Statistics

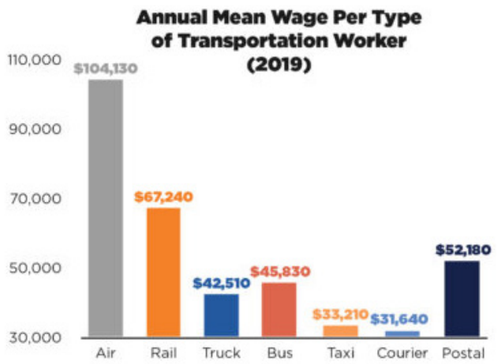
In this section, I sent out a survey seeking to understand safety concerns in regards to COVID-19 and work conditions that transportation workers might have. Here I began to narrow down on my topic to safety for transportation workers.

My survey reached 14 transportation workers, majority within the food/grocery delivery category. The results can be viewed in detail at the right.

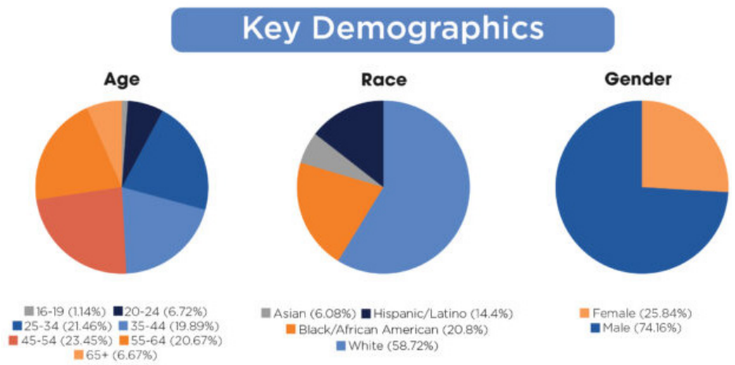
Most transportation workers noted that they feel **more unsafe at night and harassment, theft, proximity to passengers, and vehicle security were more concerning** to the participants. Quite a few comments from the participants related to **fear of violence enacted towards them while on the job**.

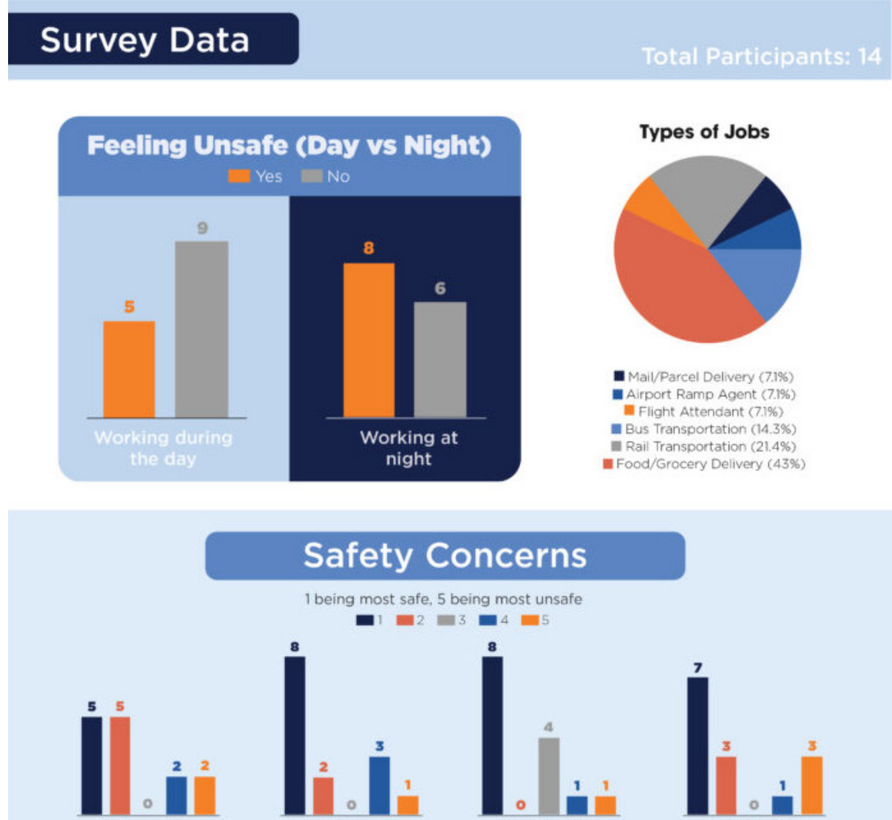
I was surprised that few of the participants were not concerned with their work environment with COVID-19 in the picture. However, it is important to understand that some receive little to no PPE, which is a concern along with the lack of social distancing and mask rule enforcement.

These survey results provided me with a **general sense of safety concerns of transportation workers**. And below are beneficial statistics from the U.S. Bureau of Labor Statistics.



"Transportation and material moving workers experienced 184,470 injuries and illnesses in 2018"





Primary Research:

Interview with a Light Rail Train Operator

After conducting the survey, I reached out to a participant, Niall*, who is a light rail train operator. From this interview, I learned about his main concerns when operating the train.

Light rail train operators have their own operator cabin separated from the passenger cabins. He feels uncomfortable being the only operator on board and prefers a

“two person crew, maybe with the conductor operating the doors, attending to medical emergencies, assisting with crowd control during heavy ridership.”

Another concern is the HVAC system, which regulates the temperature and ventilates the air in the train. According to Niall,

“all of the air to be cooled, including the air that blows into the operator’s cab, comes from the passenger compartment.”

This interview with Niall was critical to my understanding of how COVID-19 has affected the work of a transit operator. It opened my eyes especially to how **HVAC systems may be harmful and how transit agencies can be slow to react.** His transit agency provided expired cleaning wipes that did not kill the virus and there is a lack of enforcing the mask rule.

Image of a light rail train provided by Niall

*Name was changed to protect anonymity

Major Takeaways

My preliminary research allowed me to develop a deeper understanding of my topic. I wrote an op-ed on my research that encapsulates all my preliminary research, which can be found here.

Below I will identify areas for intervention and which ones I have chosen to further narrow down my topic to supporting bus drivers.

Lack of Support

Transit agencies' lack of support or slow action to provide necessary PPE, sanitation, resources, and enforcing rules puts transit workers at risk of contracting COVID-19.

Limiting Physical Interactions

Interactions with passenger need to be limited to prevent the spread of the virus. However, we should not limit all interaction, as humans require and appreciation human connections.

Verbal Violence

Transit workers experience verbal violence from unruly passengers. Threats, racial slurs, and cursing are among the most common forms of verbal abuse directed towards drivers.

Physical Violence

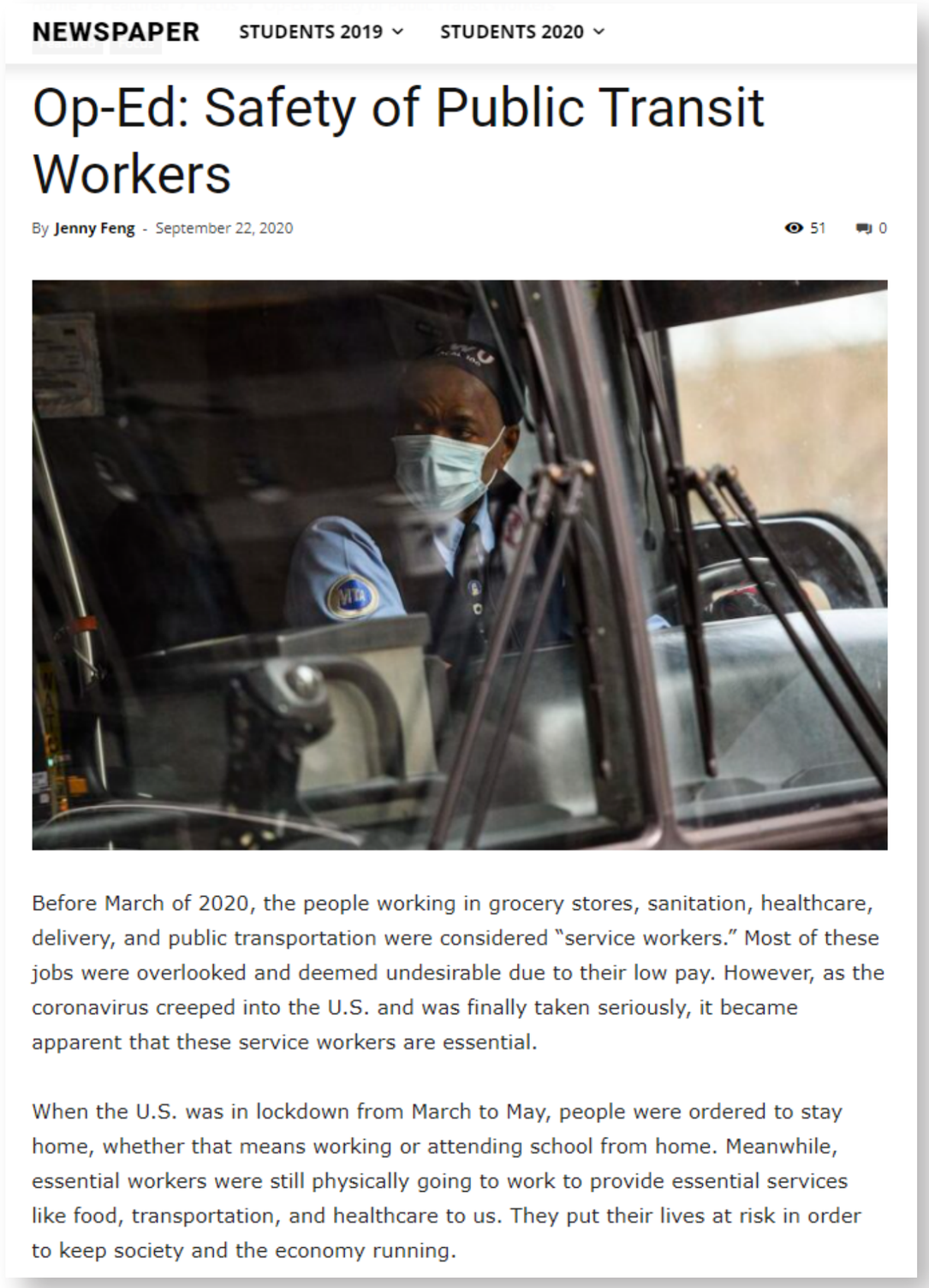
Transit workers experience physical violence from unruly passengers, often over to fare disputes. Some passengers attack, spit on, throw drinks at drivers, and in some cases end up killing them.

Work Injuries/Illnesses

Contracting COVID-19 from work is a major issues in this climate. But work resulted injuries/ illnesses, like the whole body vibration syndrome in bus drivers is common too. These injuries can develop into chronic illnesses.

HVAC Spread

Based on where HVAC components are location, the distribution of COVID-19 aerosols can pose a serious risk for all persons in the vehicle.



NEWSPAPER STUDENTS 2019 STUDENTS 2020

Op-Ed: Safety of Public Transit Workers

By **Jenny Feng** - September 22, 2020 51 0

Before March of 2020, the people working in grocery stores, sanitation, healthcare, delivery, and public transportation were considered "service workers." Most of these jobs were overlooked and deemed undesirable due to their low pay. However, as the coronavirus creeped into the U.S. and was finally taken seriously, it became apparent that these service workers are essential.

When the U.S. was in lockdown from March to May, people were ordered to stay home, whether that means working or attending school from home. Meanwhile, essential workers were still physically going to work to provide essential services like food, transportation, and healthcare to us. They put their lives at risk in order to keep society and the economy running.

Bus drivers face the dangers of interacting with COVID positive passengers and verbal and physical violence from irate passengers. They continue to provide us with the essential service of transportation as their safety and health is being overlooked. Change is needed in order to address these safety concerns for the present and future.

2. PROJECT DEVELOPMENT

OVERVIEW

This chapter is where the design begins. So far, I have narrowed my topic down to safety for bus drivers. I will take you step by step through my process. Showing the design brief, concept development, market research, bus research, interviews with bus drivers, moodboard, form iteration, and the formative assessment.

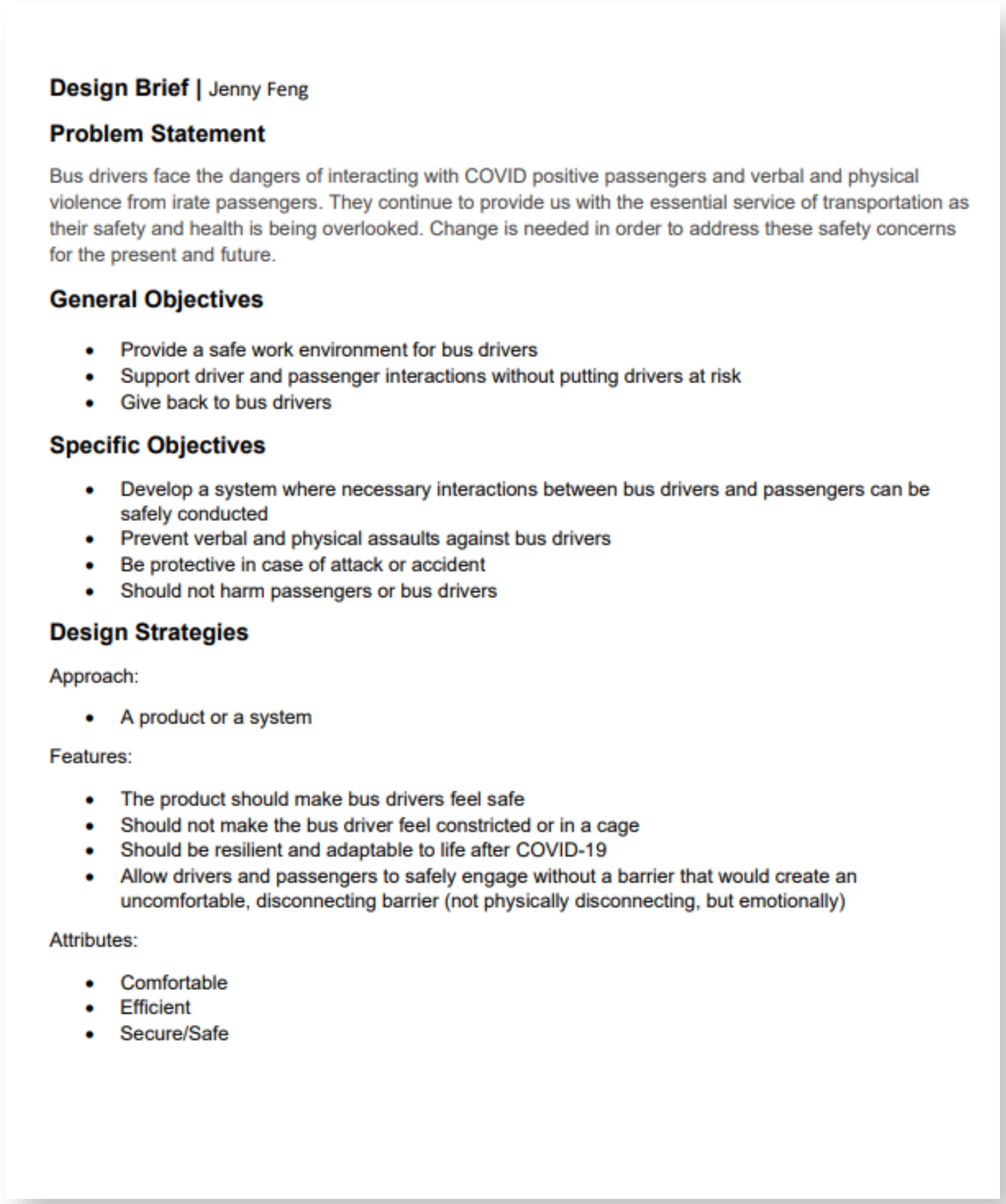
Design Brief

On the right is my design brief. This document shows the problem I will be addressing, while identifying my objectives and the features I want to include in my design.

The previous chapter revealed my problem statement, which wraps up the preliminary research I had done. The rest of the brief applies to my design process and design outcome. To summarize the goals of this brief, I plan to design a product that:

Promotes the safety of bus drivers without removing the interaction between the driver and passenger.

Acts as a safe, comfortable, and efficient environment for bus drivers and passengers.



Design Brief | Jenny Feng

Problem Statement

Bus drivers face the dangers of interacting with COVID positive passengers and verbal and physical violence from irate passengers. They continue to provide us with the essential service of transportation as their safety and health is being overlooked. Change is needed in order to address these safety concerns for the present and future.

General Objectives

- Provide a safe work environment for bus drivers
- Support driver and passenger interactions without putting drivers at risk
- Give back to bus drivers

Specific Objectives

- Develop a system where necessary interactions between bus drivers and passengers can be safely conducted
- Prevent verbal and physical assaults against bus drivers
- Be protective in case of attack or accident
- Should not harm passengers or bus drivers

Design Strategies

Approach:

- A product or a system

Features:

- The product should make bus drivers feel safe
- Should not make the bus driver feel constricted or in a cage
- Should be resilient and adaptable to life after COVID-19
- Allow drivers and passengers to safely engage without a barrier that would create an uncomfortable, disconnecting barrier (not physically disconnecting, but emotionally)

Attributes:

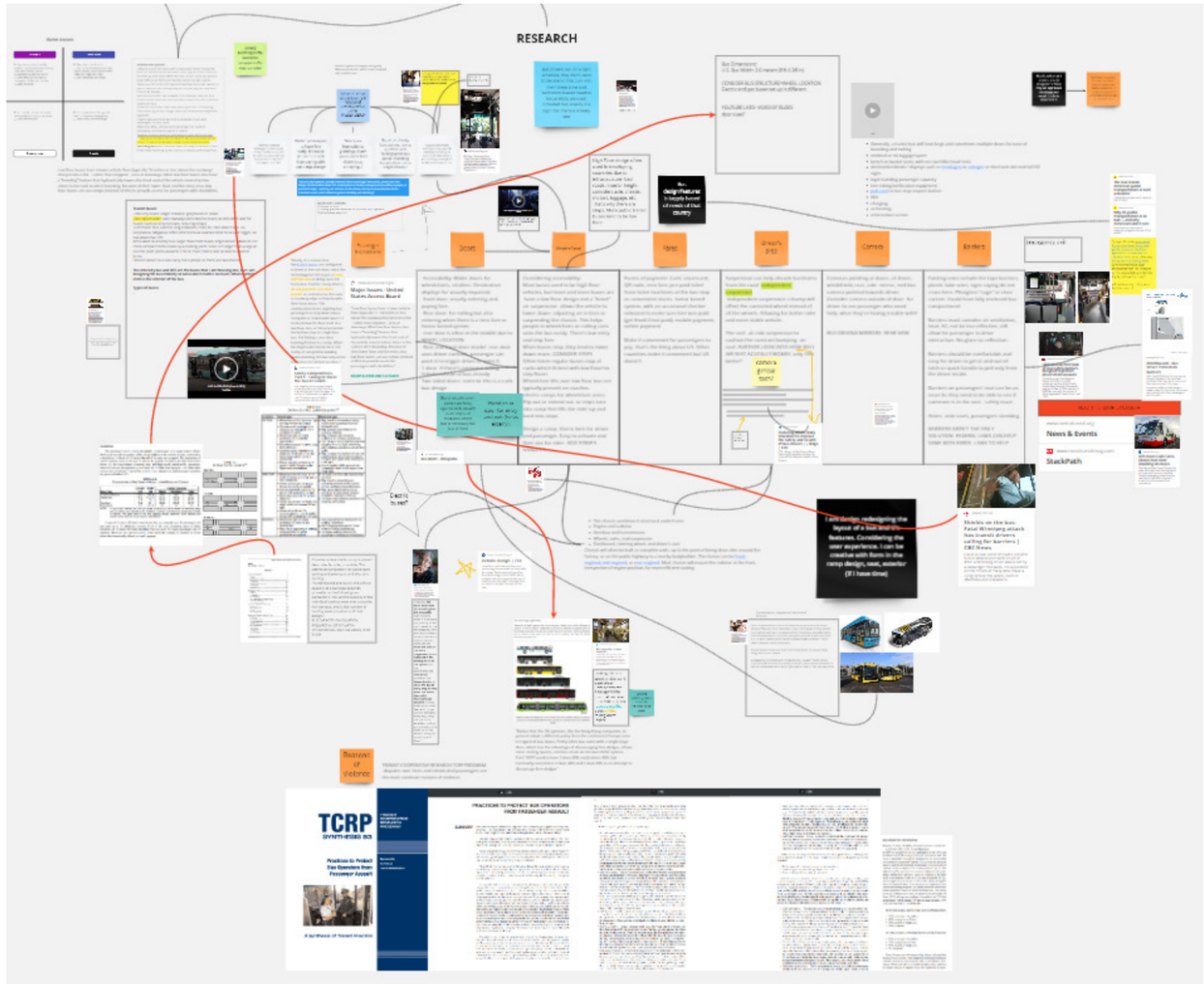
- Comfortable
- Efficient
- Secure/Safe

Methodology

Below are the steps of my process. Concept ideation allowed me to pick a project to design. Then going into various forms of research gave me the information I needed to create a well thought out design. Most of the interviews occurred quite late because I had a lot of trouble finding bus drivers and getting responses from experts. So that pushed my sketching exploration behind. I did also fall very deep into the research hole, especially when researching the components of a bus...

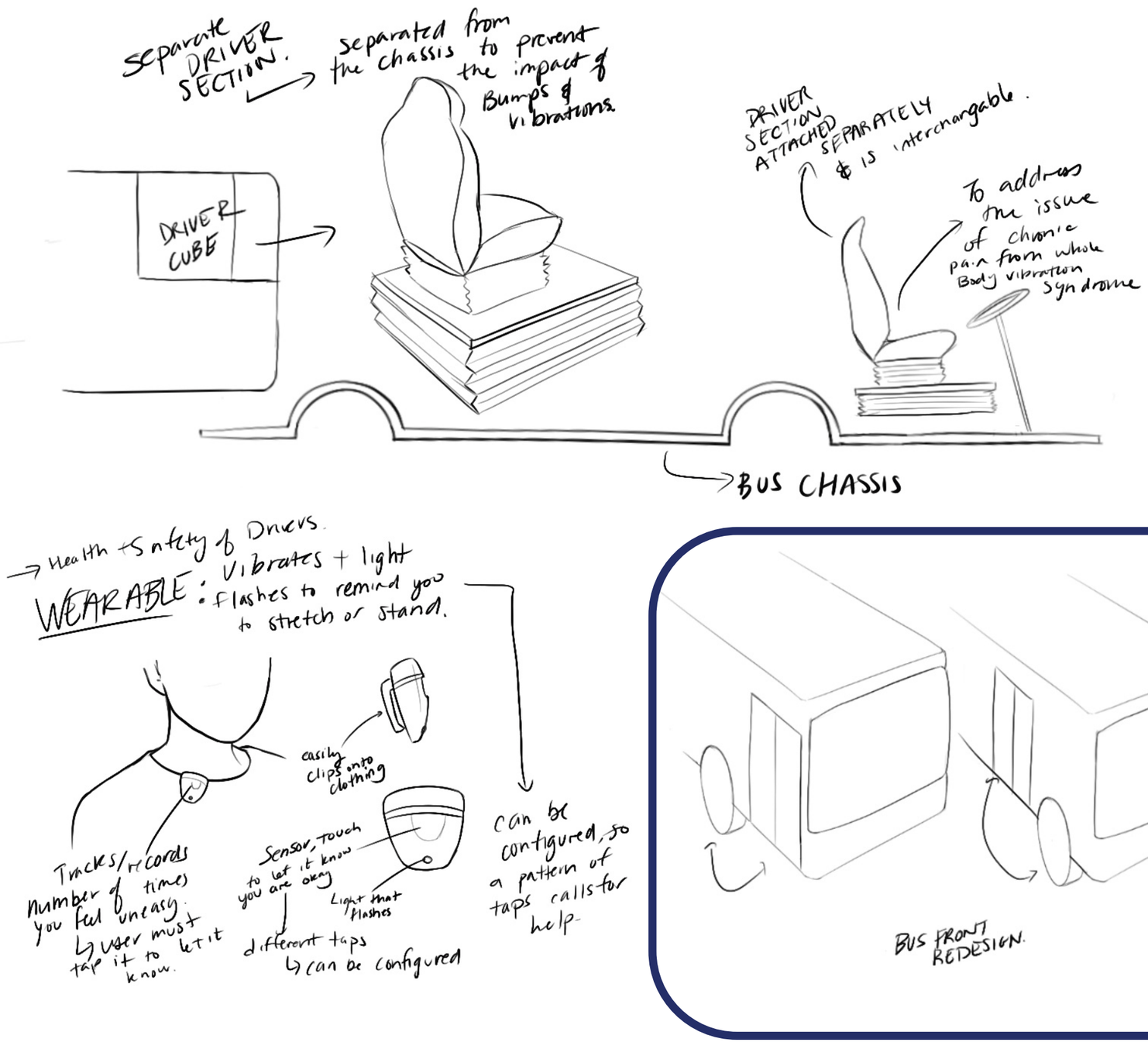
MY STEPS:

1. **Concept Ideation:** Formed potential concepts I could pursue based off of my preliminary research. This step helped me conduct more research as I narrowed down on my topic.
2. **Market Research:** Conducted a SWOT analysis and researched existing buses and systems within the bus.
3. **Bus Research:** Researched the different components of a bus. Met with a Tom Holman, the Associate Director of Transportation Operations at the Ohio State University's Transportation and Traffic Management, to learn and get an in depth view of the interior of a bus.
4. **Bus Driver Interviews:** Interviewed three bus drivers about their experiences .
5. **Moodboard:** Found inspiration for the form of my design.
6. **Formative Assessment:** Evaluated two of my hypotheses in regards to my design through surveys and interviews.
7. **Form Iteration:** Explored the form and function of my design.



A glimpse at my messy Miro board of research

Concept Ideation



This shows my preliminary concepts and the concept I ended up choosing.

I finally landed on the concept of **redesigning the front of a bus.** I thought this was a worthy concept to pursue as it would best **address the problem of safety for bus drivers.** As you will see in my research later, I added that there is a need to **address driver and passenger interaction** as well. In the end, this concept was a good choice as it gave me the opportunity to address both issues.

Market Research

I made a SWOT analysis to understand the strengths, weaknesses, opportunities, and threats that my concept would face. This SWOT analysis was updated at the end to account for changes to my concept as more features and components were developed.

I then went on to researching buses in other countries and how they are different from the ones typically seen in the U.S. Viewing what the current market has and how the form of the bus affects passenger capacity, ease of entry, and fare payment. More details on this on the next page that show the different components in the bus. That research was helpful in my understanding of what a bus needs.

Strengths

- Operator-centered, healthy operators, healthy and safer work environments
- Applicable to post-COVID era
- Safer for both drivers and passengers

Weaknesses

- Expensive to implement
- Less physical interactions between driver and passenger

Opportunities

- More people wanting to be bus drivers
- More passenger seating
- More efficient ride

Threats

- Cost of investment (do agencies even want to help their drivers?)
- Users may be resistant to chance

CURRENT MARKET

Bus Research

High-Floor Buses

- Typically have steps to reach the bus platform, making it wheelchair inaccessible.
- Seen in older buses or in modern day coaches.

Low-Floor Buses

- Easier to step onto bus from the curb, making it easier for the elderly to step on a off the bus.
- With a ramp it is wheelchair accessible.
- Low-floor buses has this **kneeling feature that lowers the bus down** by adjusting air in tires or suspending the chassis. This brings the bus closer to the ground, making it more accessible to people will all abilities.

Fares

- Forms of payment: cash, smartcard that scans, QR code, zero fare, pre-paid tickets at bus stations and convenience stores, and mobile payment.
- In some countries **fare payment is based on an honor system.** Anyone can get on the bus, but there are no tickets. Occasionally, a checker will come on to ensure everyone has paid the fare. If caught without paying the fare, heavy fines are issued.
- **Fare disputes are the most common reason for violence** against bus drivers.

Cameras

- Cameras can be found at doors, the driver, windshield, mid way through the bus, at the back, and side mirrors of the bus.

Bus Doors

- Types of bus doors: sliding doors, folding, inward gliding doors.
- Wider doors tend to be wheelchair accessible.
- European buses tend to have three doors, which allows for fast entry and exit.
- Doors are only on the opposite of the driver's side to only allow for passengers to enter and exit the bus on the curb.
- Many doors are equipped with rails/handles to help passengers get on the bus.

Driver's Seat & Air Suspension

- The **air suspension seat helps absorb harshness from the road**, which helps lessen the detrimental effects of driving on bumpy roads for long hours.
- Bus seats should provide more cushion and support since they are used for long hours.
- **Independent suspension will absorb the impact of a bump on the road** by only allowing it to affect the contacted wheel instead of all the wheels. This lessens the bumps and vibrations felt through the bus.

Barriers

- Existing barriers: tape barriers, plastic tube barriers, signage stating "do not cross," plexiglass barrier, dutch door barrier, etc.
- Barriers can be quite expensive to install.
- **Barriers put the driver into a cage and can be uncomfortable and confining for claustrophobic drivers**.
- Barriers are not the only solution to protecting drivers from violent passengers. Laws that punish attackers and controlling fare payment can help resolve.

Bus Research with Tom Holman

I met with Tom Holman, the Associate Director of Transportation Operations at the Ohio State University's Transportation and Traffic Management, to get an in depth view of the interior of a CABS bus. I wanted to learn about what the university has been doing to protect their operators and passengers and the different components of a bus. This meeting was extremely helpful to my understanding of the interior design of a bus. This also gave me the opportunity to take measurements of the interior, which aided in my CAD work.

WHAT I LEARNED:

- Ohio State University had taken action to keep the CABS bus safe and sanitized for their passengers and drivers by conducting regular cleaning and sanitation of the bus. Hand sanitizer and masks can be found on the bus. A plexiglass barrier has been installed to protect the driver mostly from COVID-19. As a campus bus, violence against the driver is not an issue, unlike on city buses. The main purpose of these barriers are to keep the driver safe from COVID aerosols.
- The barriers are made of a large sheet of plexiglass attached to a hinge near the driver's seat. A handle is placed on the plexiglass to allow for the driver to open and close the barrier easily. Magnets are used to keep the barrier secured. This barrier can close off the driver's compartment at about 120 degrees. However, at this angle, night driving poses as a problem due to reflections in the glass from light shining into the bus. These reflections could obstruct the view of the right side of the bus, which is often a blind spot. Luckily there is another option for closing the barrier. The barrier can also section off the front of the bus, where then the barrier lies around 180 degrees. With this, the reflections are not as big of an issue since it does not obstruct the view of the right side and mirror.
- The driver's seat is well cushioned and offers lumbar support. It also features the air suspension, which helps absorb the impact of bumps on the road.
- CABS have inward gliding doors that open into the bus. This allows the rails on the doors to be accessible to any passengers who need a lift or something to hold on to.
- The front door is wider than the back door to accommodate for the wheelchair ramp. Along with the wheel chair ramps, CABS buses have the ability to kneel, thus making it more accessible for all users when getting on and off the bus.
- A panic button can be found on the side of the dashboard panel. This prevents it from accidental activation.
- The HVAC system takes in air at the back of the bus and distributes clean air throughout the bus. The driver actually gets the most fresh air with how the system is set up.
- There are barriers on passenger seats to enforce social distancing and to help prevent the spread of aerosols.
- Passenger seats are set on a track, which allows the removal of a set of seats, but not individual seats.
- Seating arrangement and grab rails are strategically arranged to allow for passenger safety, so when the bus comes to a stop the passenger will not fly toward the front of the bus.

A view of the barrier closing off the front of the bus. Hand sanitizer and masks included on the bus.

View of the barrier to protect the driver and to allow passengers to enter through the front. CABS has inward gliding doors.


View of the dashboard


Panic button at the side

Interviews with Bus Drivers

I was able to **interview three bus drivers to learn about their experiences driving a bus and what their safety concerns were**. This is where I began to understand that driver and passenger interaction is very much valued and should not be eliminated even during a pandemic.

These interviews occurred quite late in my process because I had a lot of trouble getting in contact with bus drivers. Eventually, I was able to get in contact with a bus driver through a friend and found two more who were willing to speak with me through Reddit. I have been banned on a few subreddits, but I learned that the best way to get in contact with someone is by reading comments from active redditors and private messaging them. It was a journey, but I learned a lot from this experience :)

MARY

Positive Experiences:

"I love driving... difficult maneuvers it makes it more exciting... **polite passengers that actually speak to you and make you feel worth while."**

"I love driving the buses empty, gives you time to wake up and prepare for the day ahead. I like to test the brakes and how well it accelerates, gives you chance to get comfortable."

Negative Experiences/Safety Concerns:

"You are the first point of contact for customers, if they aren't happy with something that has been done, you get the grief. **People spit, punch and swear at you for stuff you cant control.** 1 man wasn't happy that I couldn't use a bus stop because it was put of order due to road works so proceeded to verbally abuse and threaten me and tell me that he hopes I get COVID-19. Generally **nobody on the bus sticks up for you either which is more hurtful."**

"**Covid has added extra obstacles because you need to make sure people are adhering to the social distancing rules and wearing a mask** which we aren't paid enough to do and quite often leads to conflict."

CHRIS

Positive Experiences:

"I like the **interaction with passengers and driving a bus in itself.** The different lines and various things you can see (sun set/ sun rise, beautiful sky, etc)."

Negative Experiences/Safety Concerns:

"I feel safe, however we recently had **a colleague who was threatened with a gun,** so that makes me a little concerned."

"I dislike drivers who overtake a bus when it is almost not possible and bikers who do not abide the traffic rules, which makes it dangerous mostly for themselves."

JOHN

Positive Experiences:

"I enjoy serving and taking care of my passengers and thrive off the energy that they emit. I know that **I am an important part of the success in so many people's lives."**

"I enjoy interacting with my riders and being friendly with them. Sometimes **regular riders become almost like family."**

Negative Experiences/Safety Concerns:

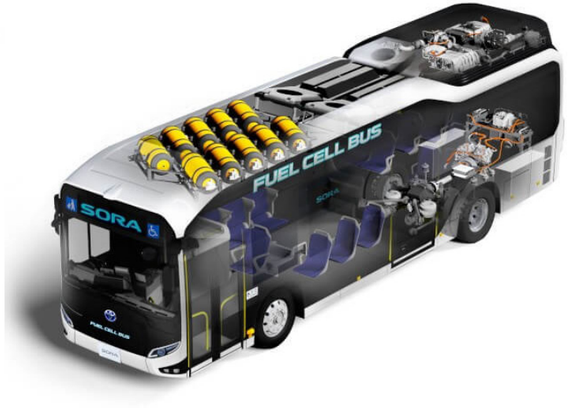
"Having the clear barriers between the drivers and the passengers **hinders/prohibits communication with the passengers which is what brings me joy** in my bus driving."

"I dislike **not being able to get out of seat for long periods to stretch and use restroom.** Sometimes we have to make bus a little late to use restroom."

"I think more mechanics or better facilities to facilitate quicker repairs on buses, like air conditioning, heating, and false warning lights. These are safety issues that need to be taken care of even when the bus is not used."

*Names have been changed protect anonymity

Moodboard



These images served as inspiration for my design aesthetically, as well as functionally. I wanted to go for a **curved yet angular design** and found these images helpful. Some of the images were a resource to refer to when considering the technical components within a bus.

Formative Assessment

For the formative assessment I wanted to see how both bus drivers and passengers felt about interacting with each other and what barriers they thought were most effective.

I asked about how the location of doors affected their desire for interaction because one of my ideas featured a design where the front door and front wheels were switched. I also noticed that many buses stopped front door entry due to COVID-19, so I wondered how that affected interaction. Overall, I found that both **passengers and bus drivers were mostly neutral and enjoyed the interaction.**

As for barriers, I asked the participants to rate existing barriers and a quick barrier design I made. I found that there are two types of barriers, one that is directly attached to the driver's cubicle and one that enforces a distance between the passenger and the driver. The first type of barrier had the best ratings and the participants identified that **a good barrier should be spacious, sturdy, full-coverage, and non-reflective.**

I found the formative assessment to be extremely helpful to my research because it put my design and ideas to the test and allowed me to gather insight from the stakeholders themselves.

After these findings, I made an adjustment to my design brief. Instead of purely focusing on bus drivers' safety, I wanted to also address the issue of interaction. Interactions must be limited due to COVID-19, but as a result the pandemic, people are more depressed and lack connections with others. Especially if bus drivers do enjoy speaking with passengers, they should have the ability to do so, but in a safe environment that can protect both parties.

CHALLENGE:

Jenny Feng | 17 Participants

COVID-19 made it apparent that bus drivers are risking their lives to provide transportation to all and has also caused an increase of violence towards drivers on top of the verbal and physical violence that they already experience from irate passengers and those who share the road with them. The goal of this project is to provide bus drivers with a safe work environment that they deserve.

Hypothesis

If the opportunity for the interaction between bus drivers and passengers during the beginning of a ridewas eliminated due to no front-door entry, neither party would be negatively impacted (during and post-COVID), however, this initial interaction will be missed.

Question | Doors

Do passengers and drivers enjoy interacting with one another?
How does door location and entry affect their desire for interaction?

Method | Survey and Semi-structured Interviews

Participants filled out the survey and a few were interviewed to better understand their thoughts on interactions in relation to door location. Utilized purposeful sampling as my target sample needs to be bus drivers and people who have been on a bus.

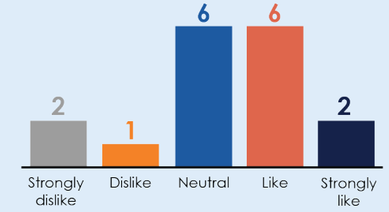
Indicators

1. Enjoyment of interaction
2. Door location and entry preferences

Results

Most passengers enjoyed interacting with bus drivers, though a few noted disliked this interaction due to anxiety and general indifference. Most bus drivers enjoyed interacting with passengers, noting that friendly passengers brighten their day.

Interaction Between Bus Drivers and Passengers



When asked how the discontinued use of the front door affected bus drivers' desire to interact with passengers, many said:

"It would make it a lot harder to interact with the passengers which I wouldn't like."

"I would still try to speak with the riders closest to the front."

To this, most passengers said that no front door entry would cause them to interact less with the driver or find no need to interact with them all together.

Door Location Preferences

Design Lessons

Front door entry is still desired for ease of access for passengers and more interactions with drivers.

Bus drivers still want to speak to passengers so a design that does not fully prevent interaction, but still protects drivers is necessary, especially after COVID-19.

Hypothesis

A protective barrier for the bus driver is a necessary addition to the bus. One that gives the driver personal space, does not eliminate all interaction, and does not put them in a cage would appeal to both the operator and passengers.

Question | Protective Barriers

How effective are existing barriers and my design?
What are valuable features that an effective protective barrier should have?

Method | Survey and Semi-structured Interviews

Participants filled out the survey and a few were interviewed to better understand their thoughts on different protective barriers. Utilized purposeful sampling as my target sample needs to be bus drivers and people who have been on a bus.

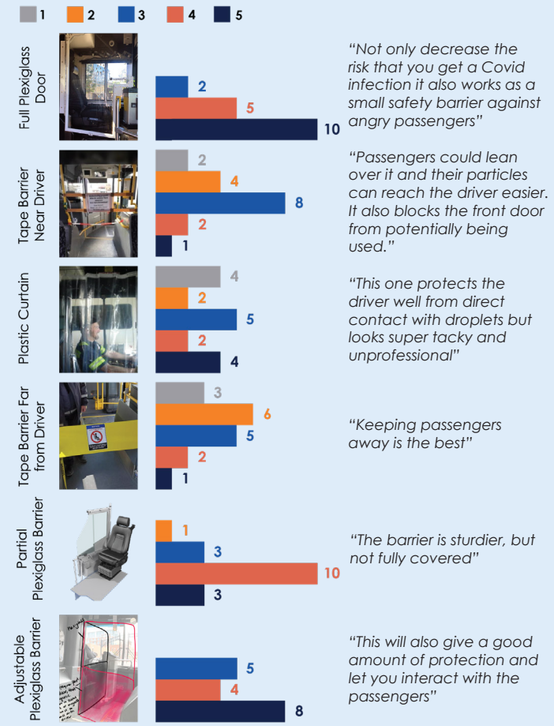
Indicators

1. Rating of barriers
2. Important features described

Results

Rating of Barriers

(1 being least effective and 5 being most effective)



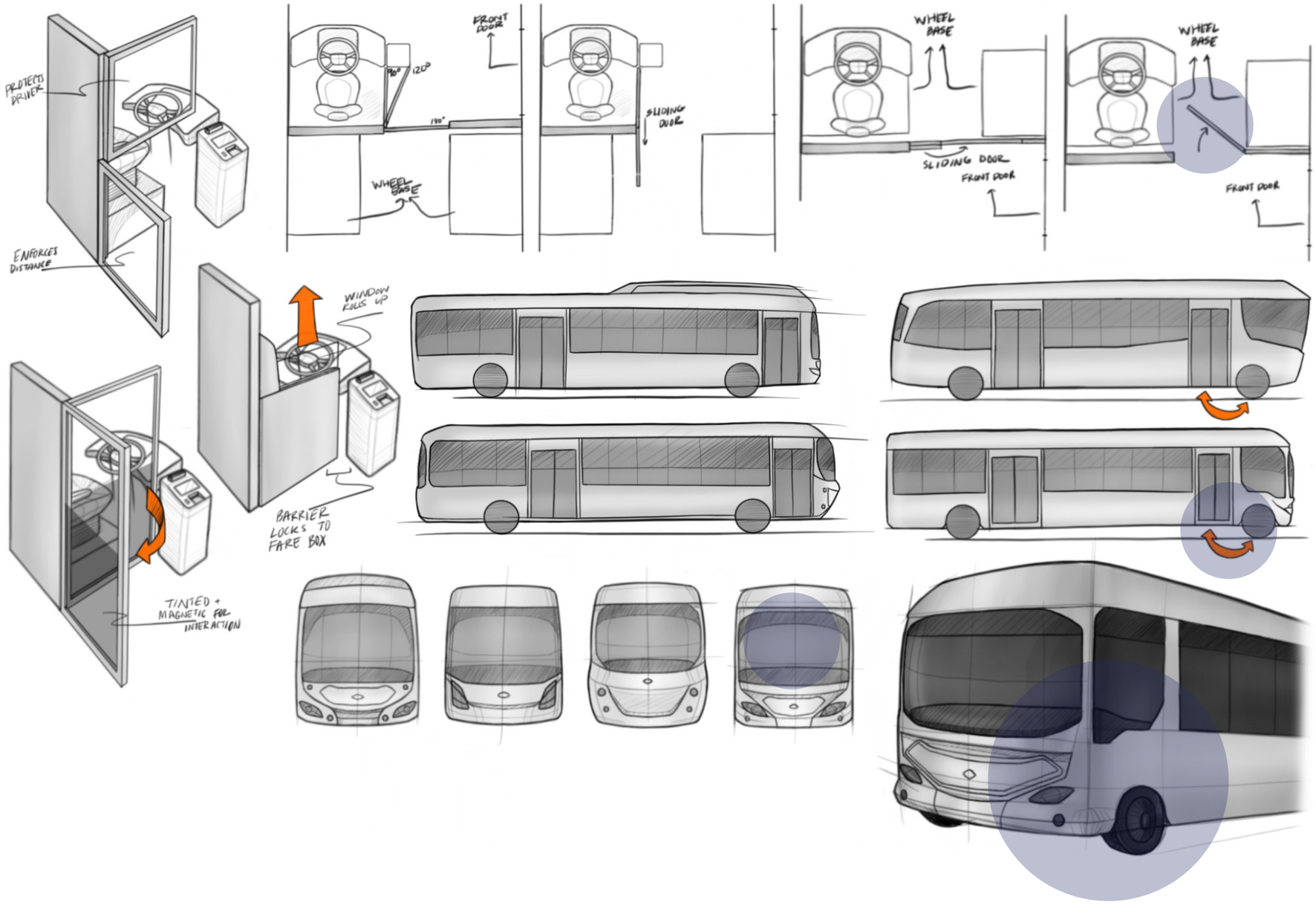
Valuable features: Space, non-reflective, sturdy, full coverage, affordable, professional

Design Lessons

Full coverage and sturdy barriers are most beneficial as they protect drivers from droplets and physical attacks. They tend to be easier to clean and more professional.

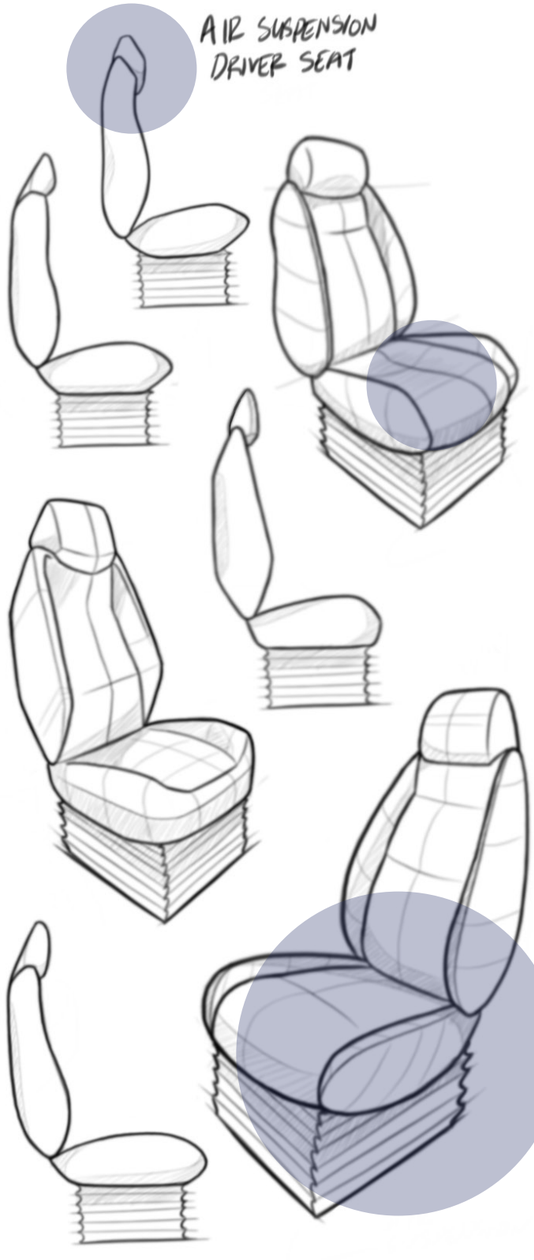
Barriers should not trap the drivers as 6 ft distance between drivers and passengers is ideal during the COVID-19 pandemic, however, drivers should have more space for better mobility.

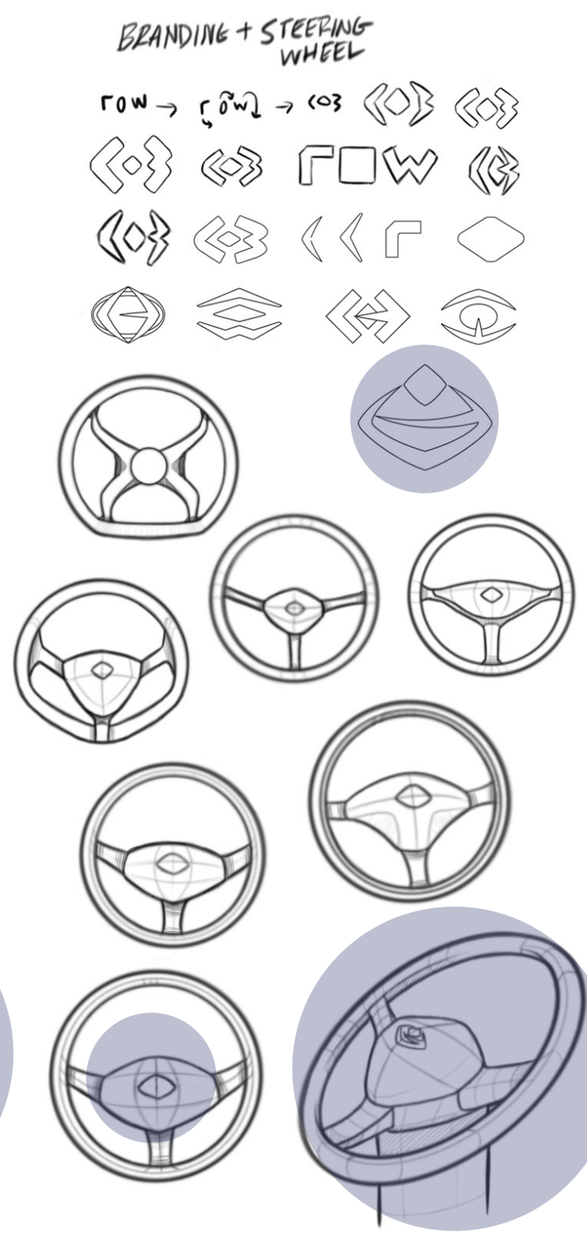
Form Iteration: Barrier and Bus

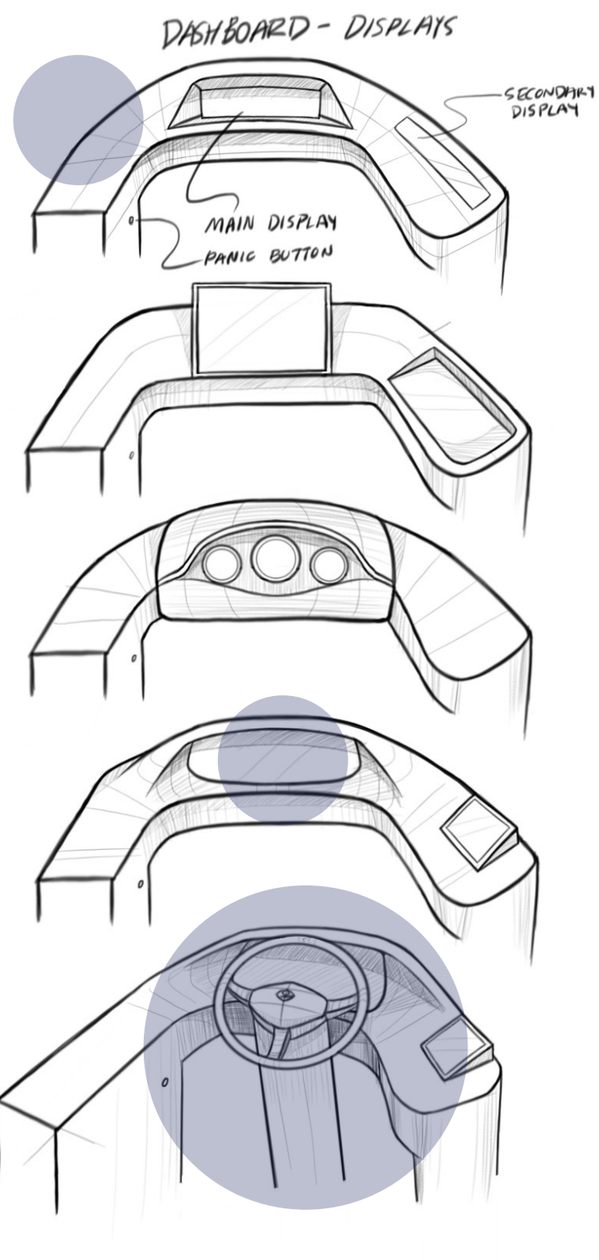


I thought that designing a new barrier that fits with a specific bus front will be the most effective solution. However, after the formative assessment and looking back at all the information I learned from previous research, I realized that the best way to approach this is by **switching the front door and wheels of a bus. This will then solve the problem of reflections** in the glass barrier due to the angle of the barrier that then obstructs the view of the mirrors. By switching the front door and front wheel, this allows for a **separate driver cabin**, similar to one in a tram. This protects the driver from the spread of COVID-19 and violent passengers. After this realization, I began to design the door to the driver cabin. I looked at glass sliding doors, but they were heavy and would not fit properly. I decided on a regular door with a window option at the side.

Form Iteration: Interior







This section features form iteration for the driver seat, steering wheel, and dashboard. Designing a dashboard is quite an extensive project on it's own so I left the dashboard quite simple. I just added elements I thought were necessary to promote safety and interaction. The features will be explained in the next chapter.

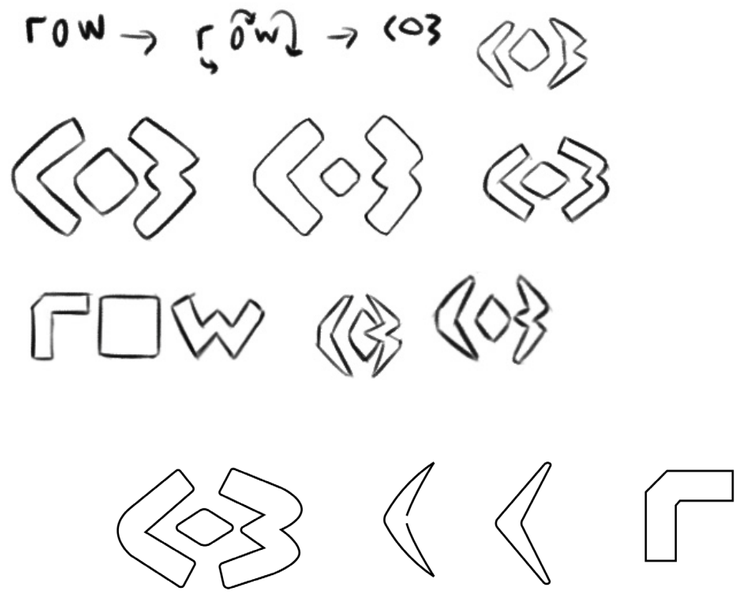
I also did not design passenger seating since that is also another extensive project that requires even more research and development that would be difficult to manage in only one semester. But potential seating increased due to the bus design.

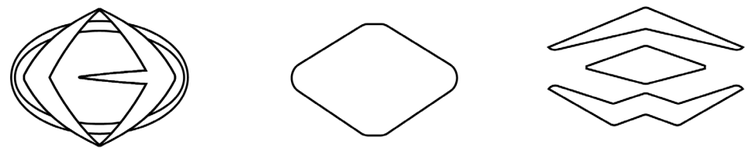
There is **no fare box because the driver will no longer we overseeing fare payment,** thus creating more space for the driver and eliminating fare disputes.

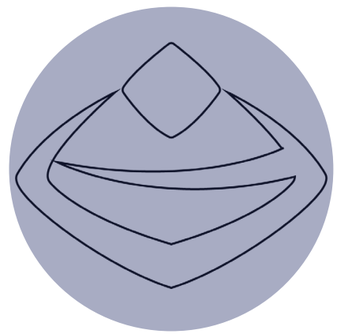
Form Iteration: Branding

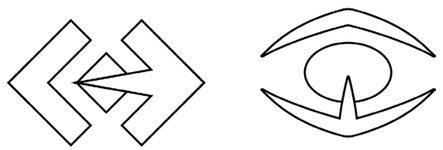
Colors for the digital product and the bus

Car Logos for Inspiration









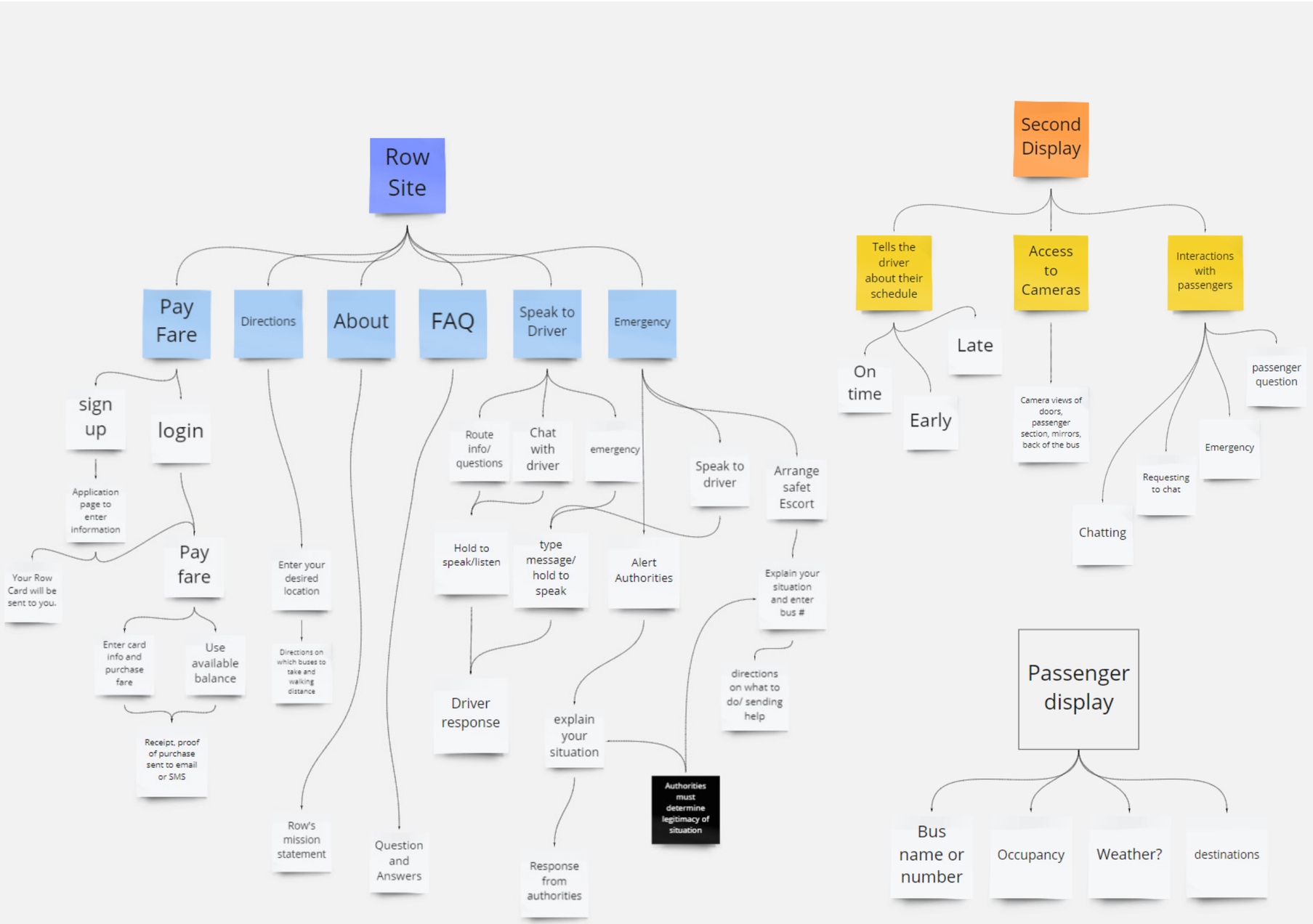
I was inspired by many other car logos and how they featured curves and were sleek. I started with a relatively bulky logo and graduated to designing one that gives off the vibes of a car logo. Which I think is fitting.

I started a few rough sketches of the logo and moved into Illustrator for more polished iterations. That's when I realized that the bulky look was not the way to go.

The name of my design is Row. The name plays a role in the form of the logo because the logo is made up of the letters 'r,' 'o,' and 'w.'

I also noticed with the final logo design, it looks like a person holding out their arms as if they were hugging someone. **This embrace symbolizes our action to keep bus drivers and passengers safe.** This logo shows that we want to protect them and keep them safe from COVID-19 and violence.

Form Iteration: Interface



This section is not so much form iteration, but more like interface iteration. Here I went in to design the mobile site for Row. I also designed the display for the bus and the monitor on the dashboard. This is more of a look into information architecture.

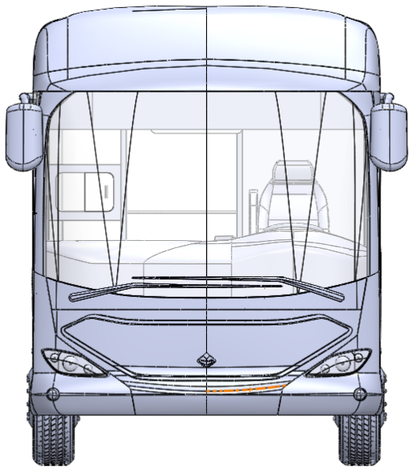
I felt that there was a need to include **the mobile site and the dashboard monitor because this can facilitate safe passenger and driver interaction.**

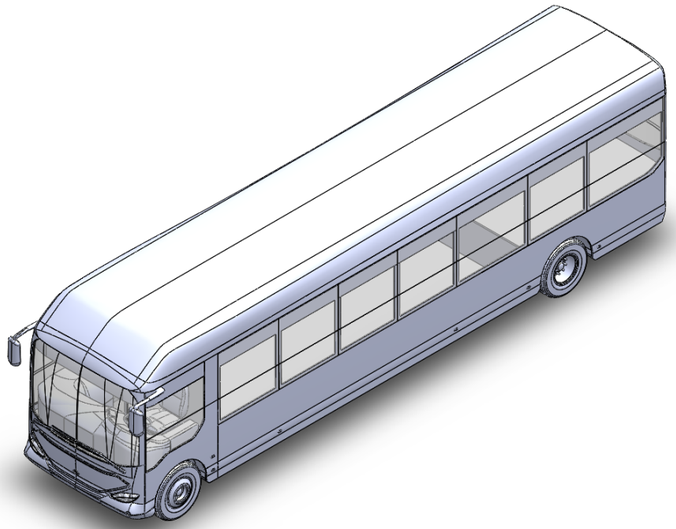
2. DESIGN PROPOSAL

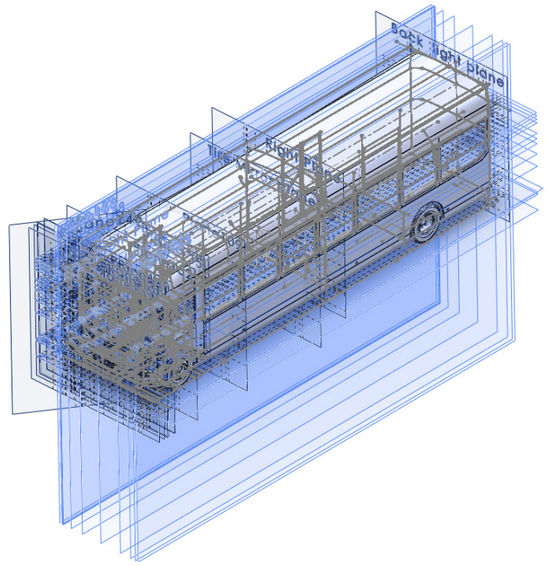
OVERVIEW

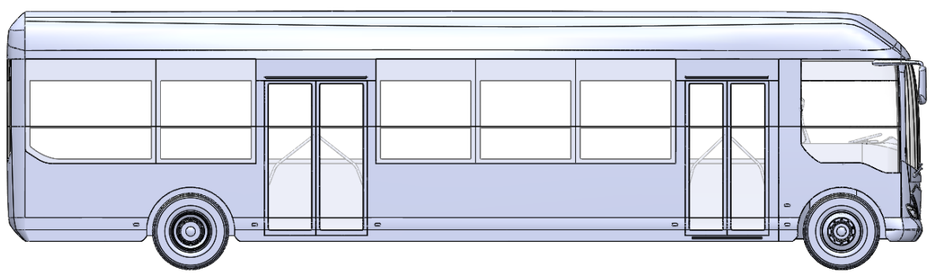
This chapter will show the final result of this semester's research and project development. Here, you will get to see the details of my CAD work, the various visualizations, and an in depth explanation of my project and how it serves to address the issue of safety for bus drivers while promoting driver and passenger interaction.

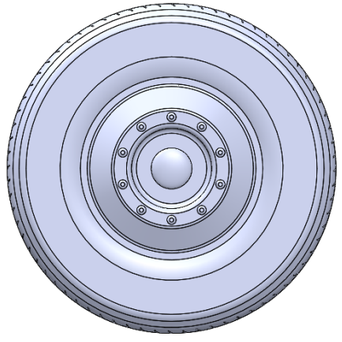
CAD Design

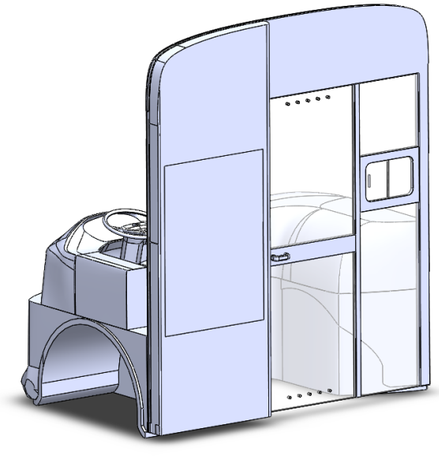


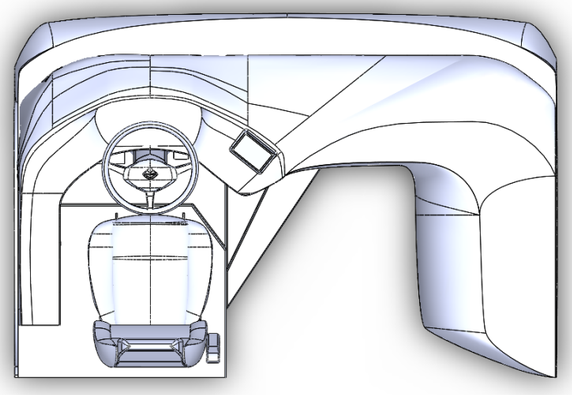


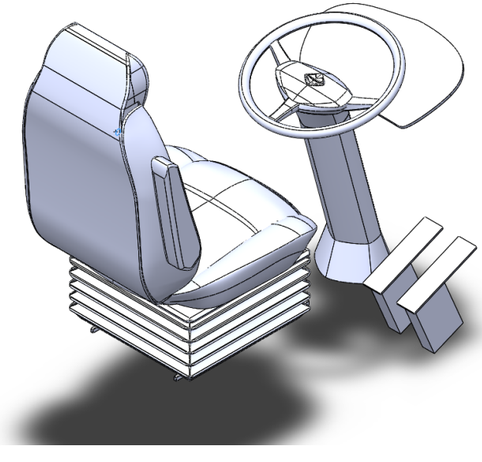










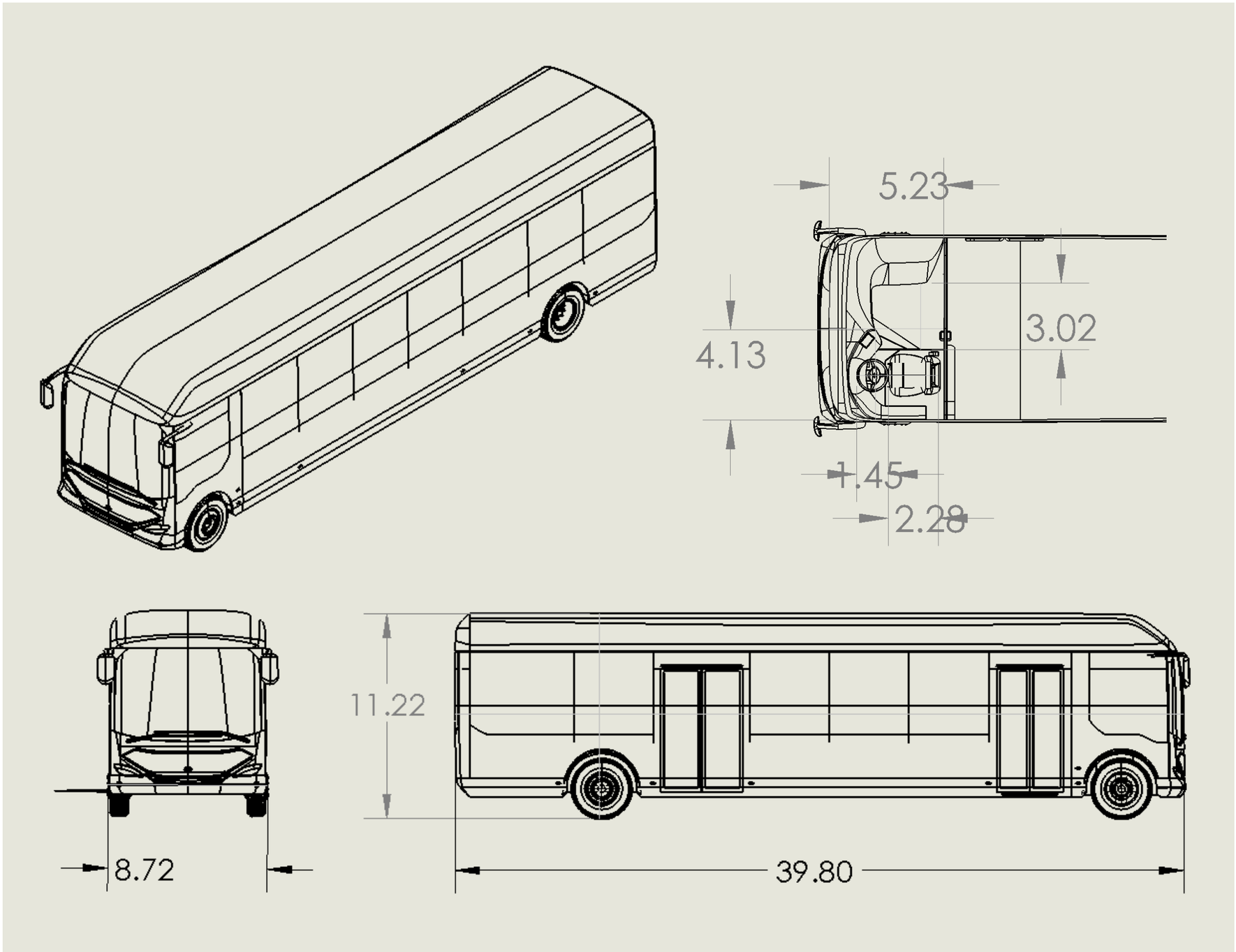


This page shows the different parts of the bus: seat, steering wheel, dashboard, driver cabin door, large passenger display, and the bus itself.

This entire bus took about 2 weeks to complete. It is by far the one of the most complicated things I had to model and I think I made it quite fast as well.

Looking back, I could've been more resourceful and grabbed the tires off of GrabCAD. That would've sped up my process. However, I am proud that I was able to model everything myself.

Technical Drawings



Row comes in these available colors:

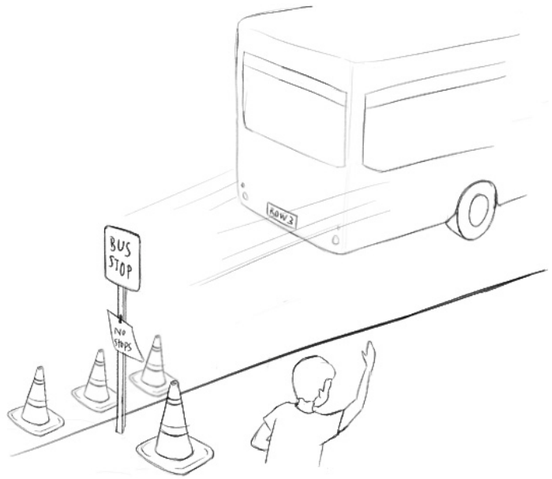
- #ffffff
- #ed7020
- #272f69
- #434343

These technical drawings of my bus. It stands 11.22 ft tall, 8.72 ft wide, and 39.80 ft long.

The actual CAD model in SolidWorks is not that big it is actually 11.22 cm tall, 8.72 cm wide, and 39.80 cm long.

Scenario of Use

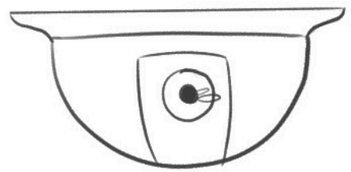
Row Protects Drivers



1. Due to construction, this bus stop is not in service, so the driver stops at the neighboring stop.

2. Passenger is angry at the driver for not stopping at their desired bus stop.

3. Passenger gets violent and throws their drink and pounds on the door. Thankfully the driver is not harmed.

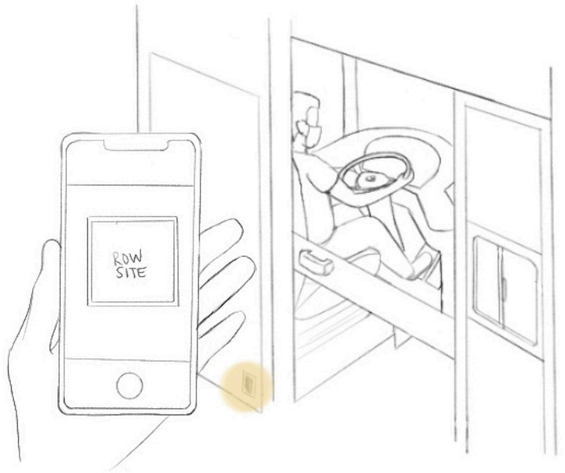


4. The camera above catches this incident and footage will be reviewed.

Row Encourages Interaction

1. Driver opens the window to allow for socially distant interactions.

2. Passenger greets the bus driver. Eye contact is made and the greeting is heard.



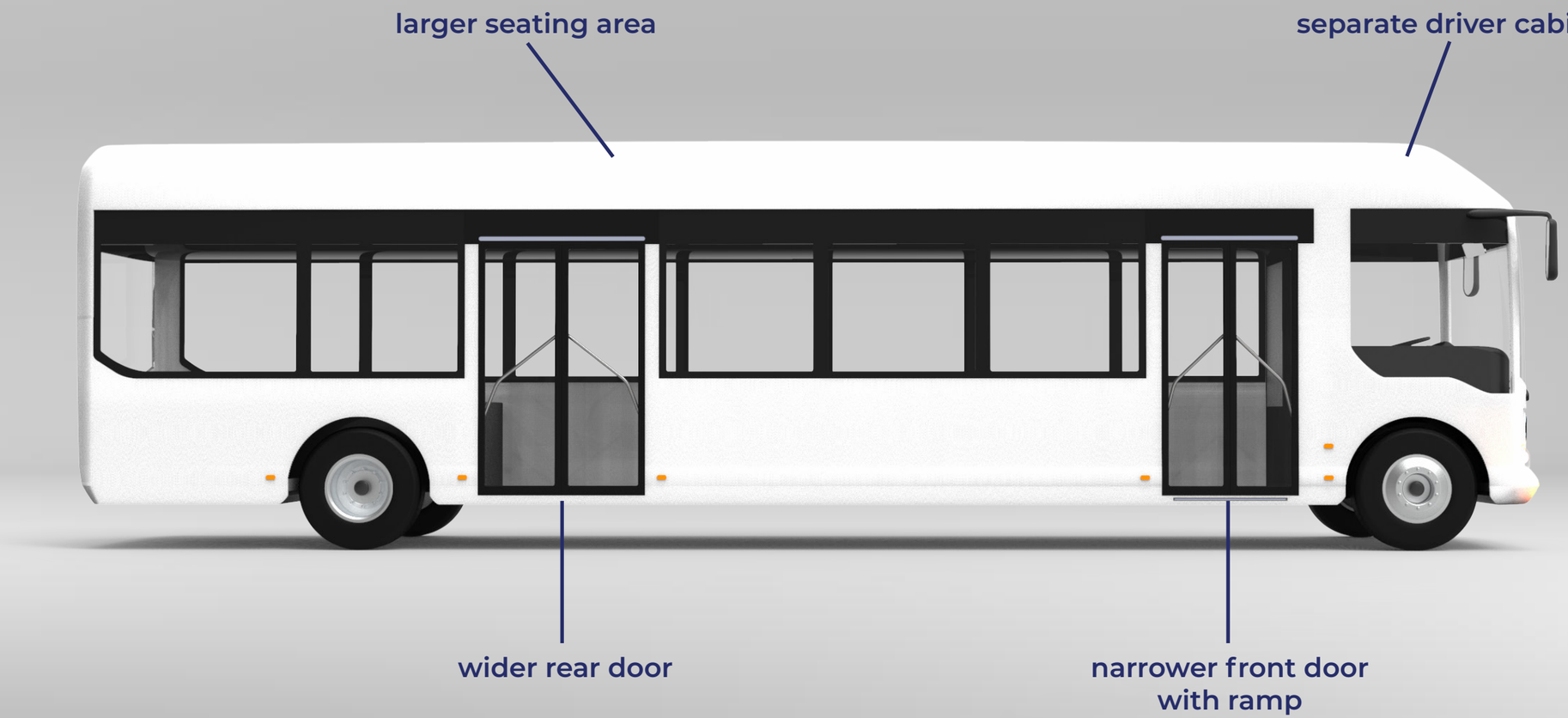
3. Passenger scans QR code to take her to the Row site. This can allow her pay her fare and speak to her favorite bus driver, when they are available.

4. Passenger speaks into phone and the message is transferred to the driver's secondary display. Now they can have a conversation.

ROW

Row is a concept electric bus designed with the safety of bus drivers in mind. It is a low-floor electric bus with a separate driver cabin aimed to protect drivers from violent passengers and the spread of COVID-19. Combined with a new fare and interaction system, Row acts to promote passenger and driver interaction while keeping both parties safe.

ROW: Exterior

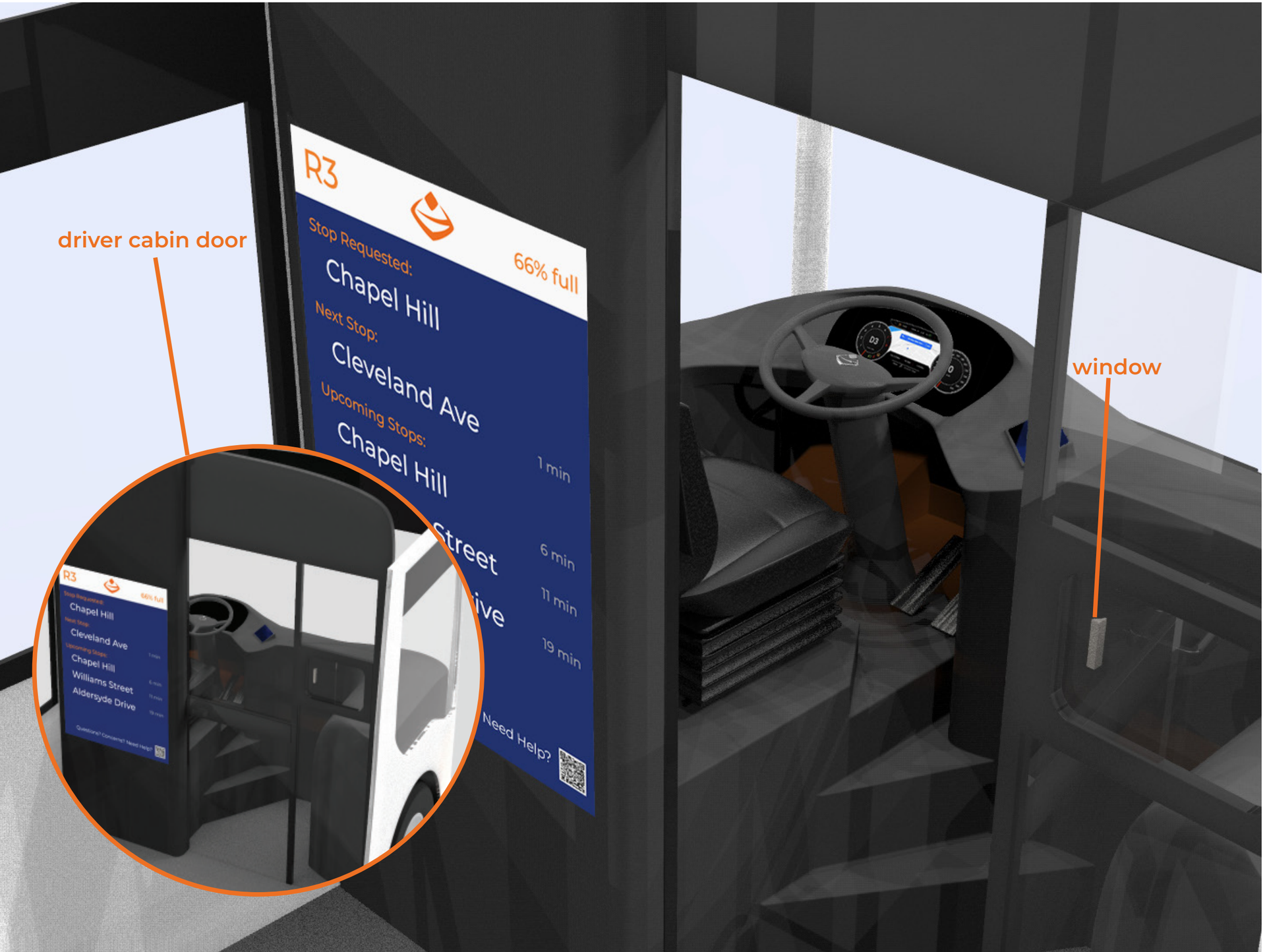


Existing buses are designed to keep the passengers safe, but drivers' safety remain an afterthought. **Row is an electric bus designed to keep both the driver and passenger safe.**

By switching the location of front door and the front wheel, it allows the driver to have **a separate driver cabin.** The driver sits a higher up because the wheel arch is now right underneath the driver cabin. When passengers enter, the driver is no longer the first person they see. But when they turn to scan their card, they will see the driver.

Row features a **narrower front door to encourage mostly entry** but it is still wheelchair accessible. The **rear door is wider to allow for entry and exit**. With this design, it allows for **more seating space because in a normal bus** since the front wheel arches take up a lot of space, but with Row the wheel arches are no longer an issue.

ROW: Driver Cabin



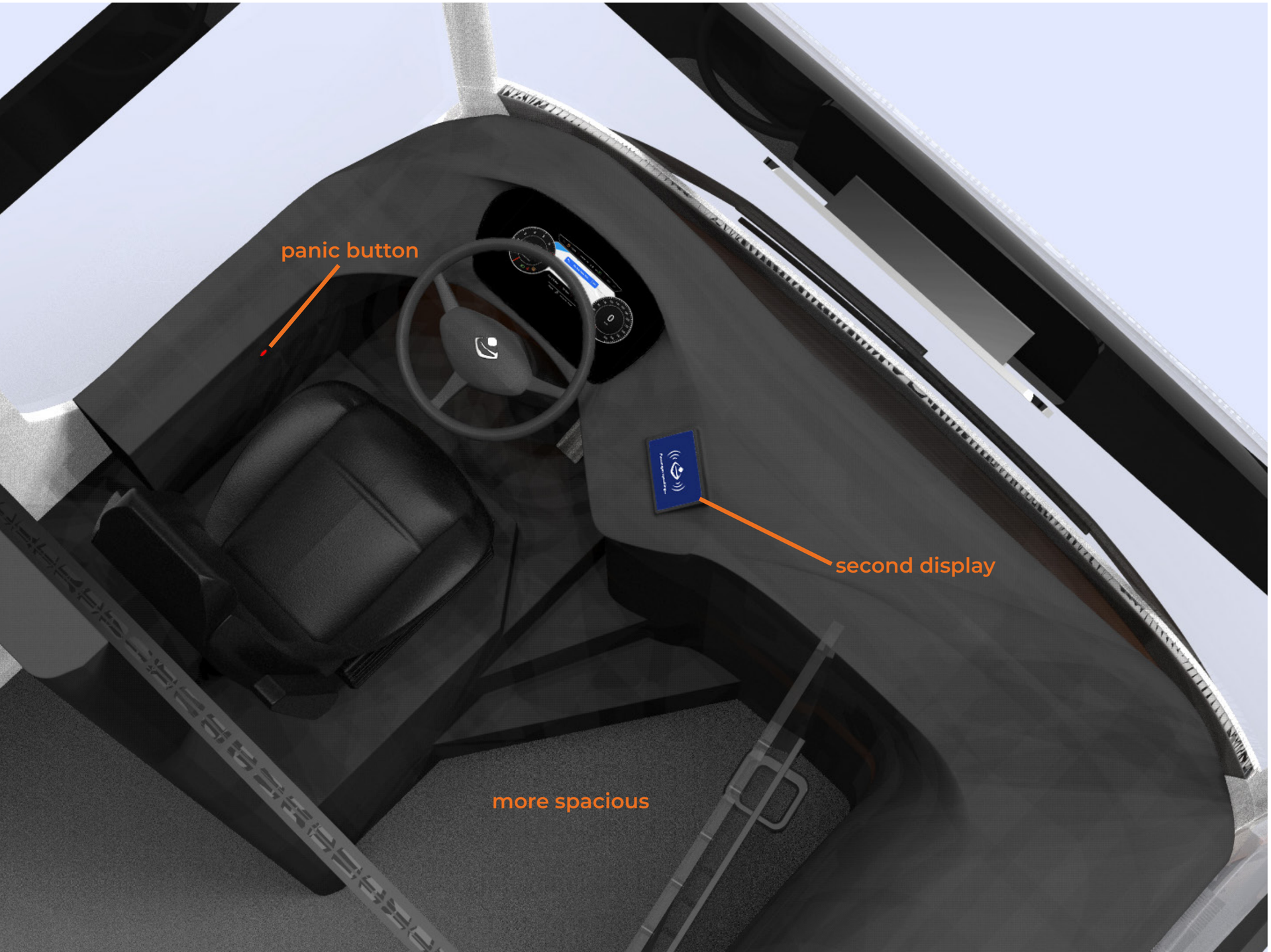
The driver has a separate cabin similar to that in a tram. The **door to the driver cabin is made of glass** to allow the driver to see into the back of the bus.

The door can be left open or closed to allow for interactions with passengers post-COVID or if the driver is comfortable. Or the **window can slide open to allow the driver to still greet and talk to passengers and listen** to the passenger section.

This sturdy glass door will protect drivers from physical attacks, spit, drinks being thrown at them, and can deafen the sound of explicit language. **A camera sits above the door to capture any attempts at violence.**

Speakers and mics are embedded at the bus doors so the driver can hear and communicate with passenger at both the rear and front door without needing to other the cabin door.

ROW: Driver Cabin



Due to the separate driver cabin, the **driver will not feel confined.** Many barriers put drivers in a tight space, however, with Row the driver has their own spacious cabin.

Having a separate cabin can **decrease the number of distractions** coming from the passenger section and allows the driver to safely store their personal belongings there.

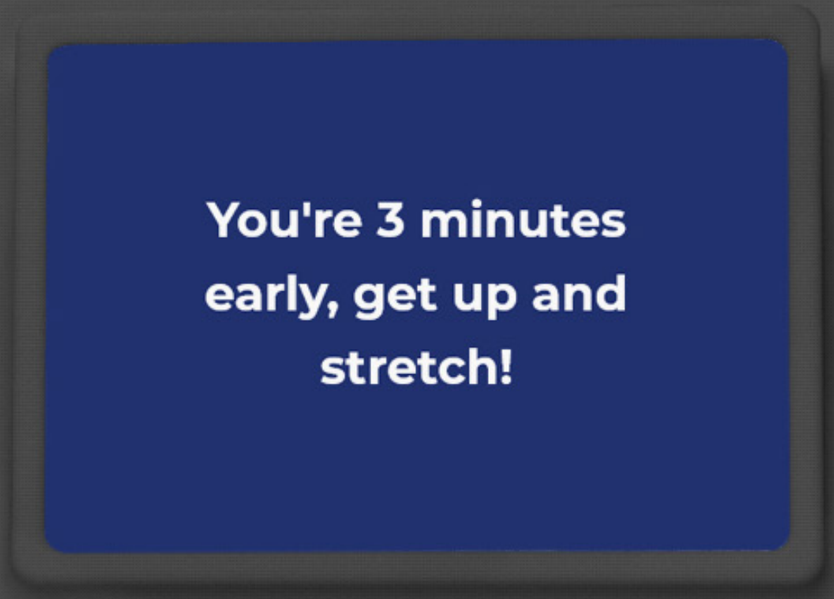
The door can only be locked from the inside, so a passenger cannot enter the cabin when locked.

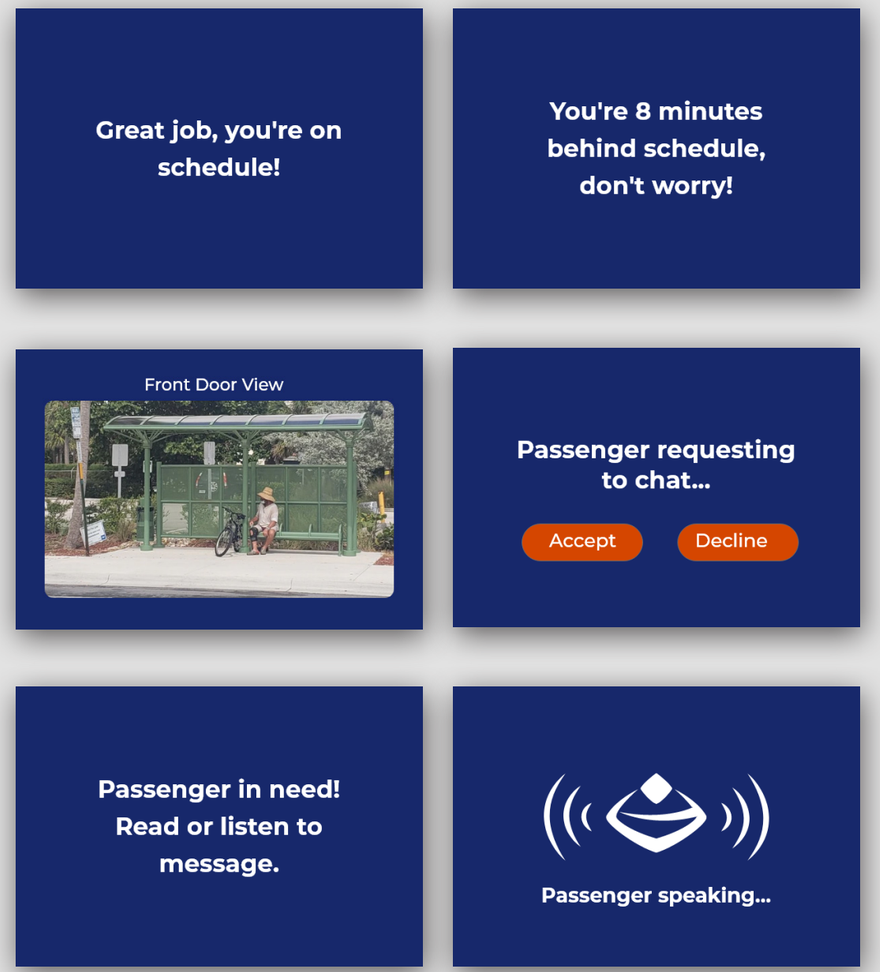
The driver's seat is well cushioned and contains the air suspension support.

A panic button is placed at the side to prevent accidental activation, but is still accessible.

A dashboard display and secondary display will aid the driver.

ROW: Second Display





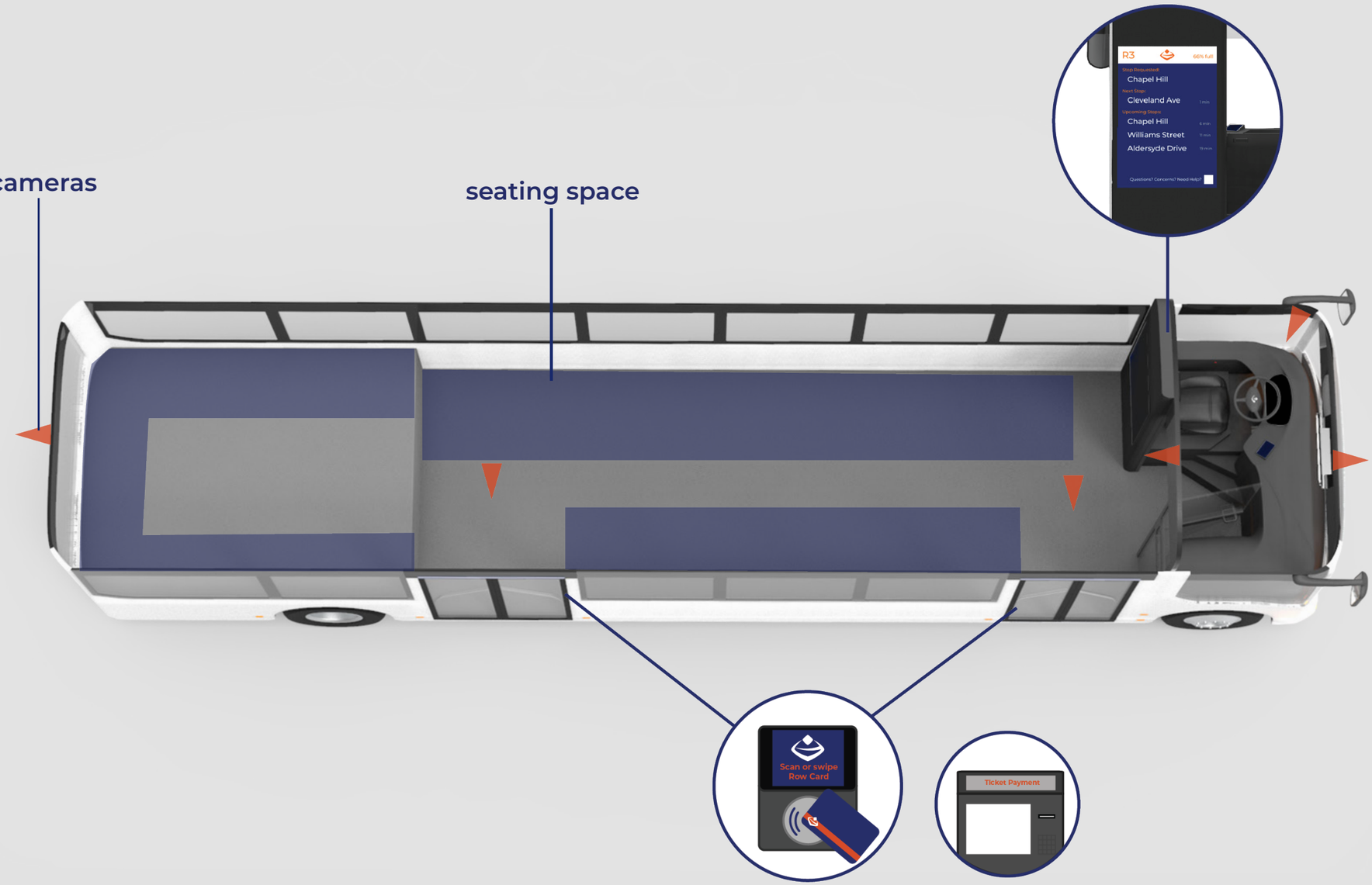
The **secondary display is synced to the driver's schedule.** It will notify the driver if they are early, on time, or late. Also reminding them to get up and stretch and acts as encouragement.

The **display is voice and touch controlled**, so the driver can activate it hands free. The display can read aloud text and show text.

Passengers can communicate to the driver through the Row mobile app and the conversation occurs through this display.

Camera angles can be accessed through the display.

ROW: Interior



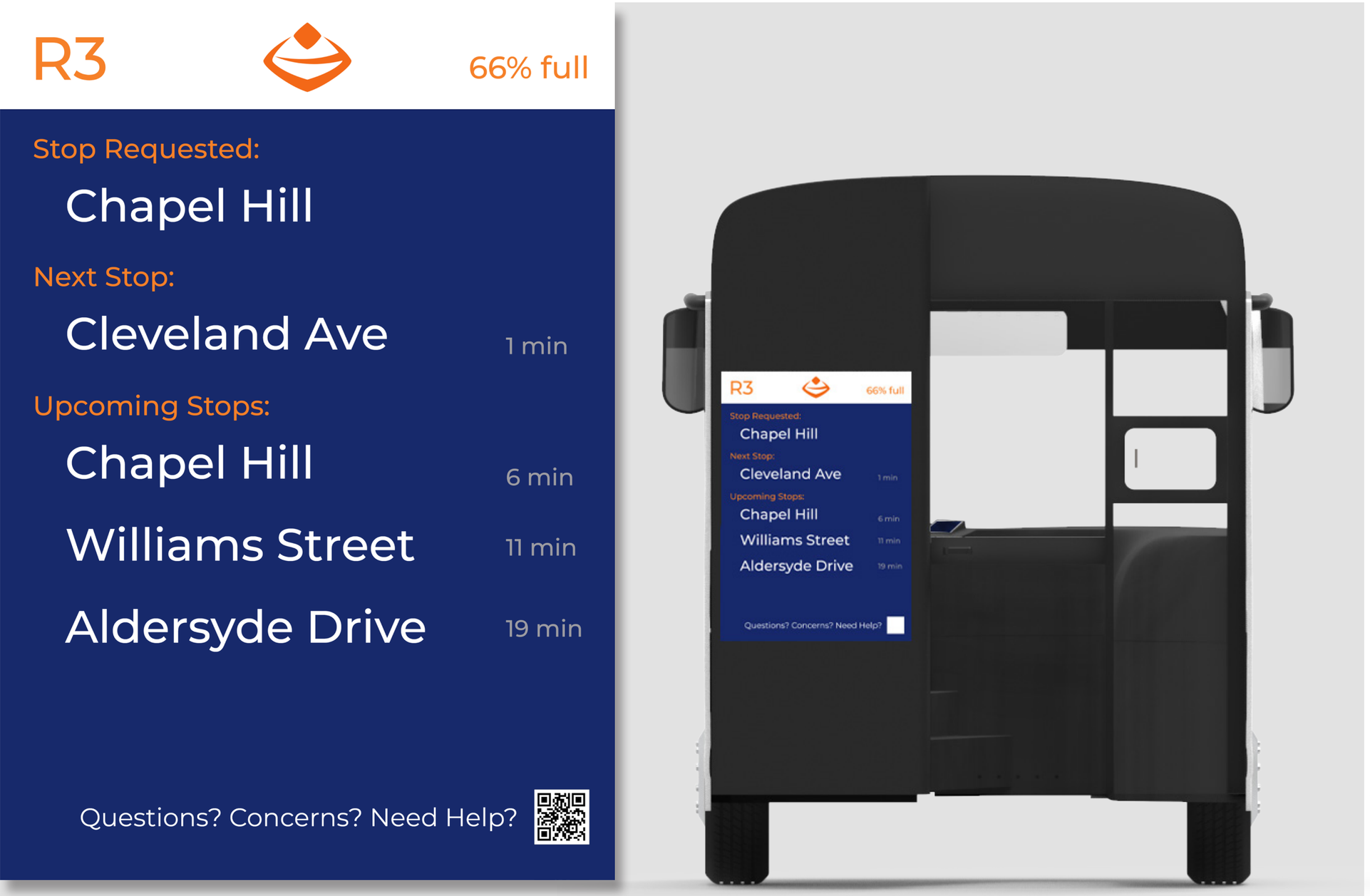
Passengers can enter through both doors. At the machines by the doors they can swipe or scan their **Row Card, which can be obtained online or at a Row Kiosk found at select bus stops and select convenience stores.** At the kiosks, passengers can pay and upload money onto their Row Card by cash or credit. A Row Card is required for entry, anyone caught without paying or a Row Card will be fined.

There is no fare box so no cash payment is allowed on the bus, so the **driver does not oversee fare payment thus eliminating fare disputes** and allows for quick and easy entry.

Cameras throughout the bus serve multiple purposes, such as **surveillance, blind spot checkers, and allow the bus driver to see passengers if they need assistance.**

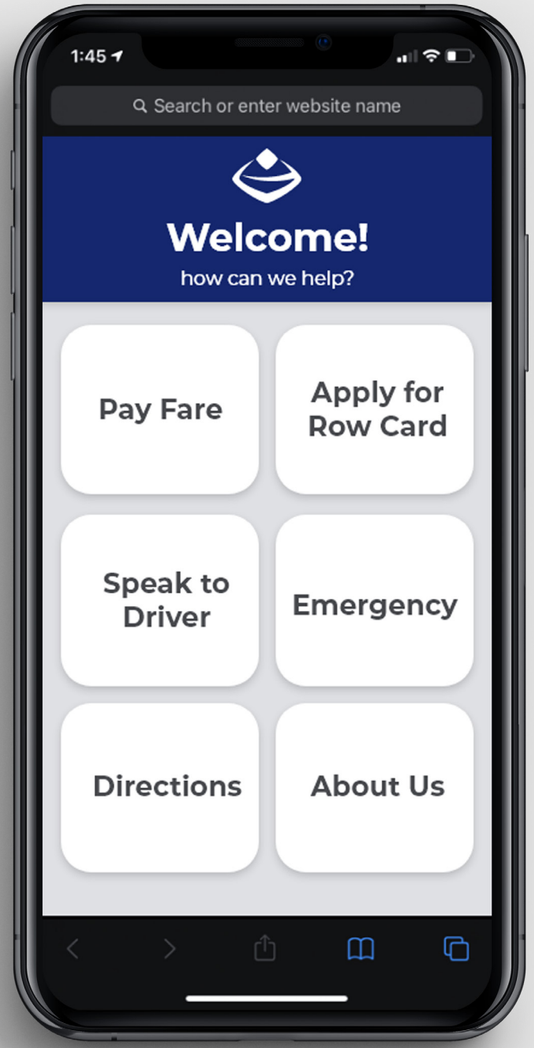
Due to the design of the bus, there is **more passenger seating and passenger can sit closer to the driver,** which allows for more interaction especially effective post-COVID. Passengers can also view the large destination display.

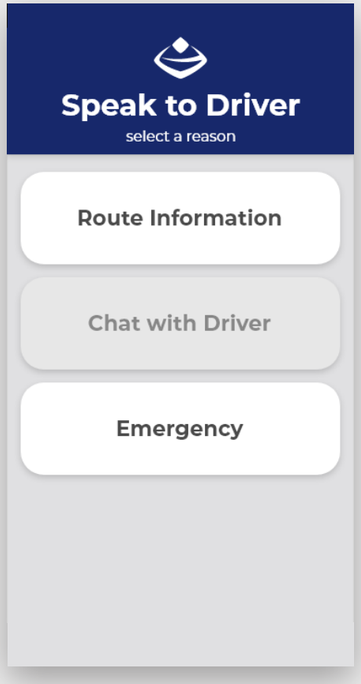
ROW: Passenger Display

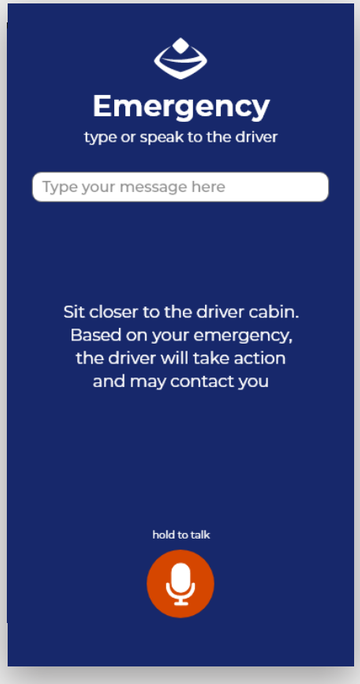


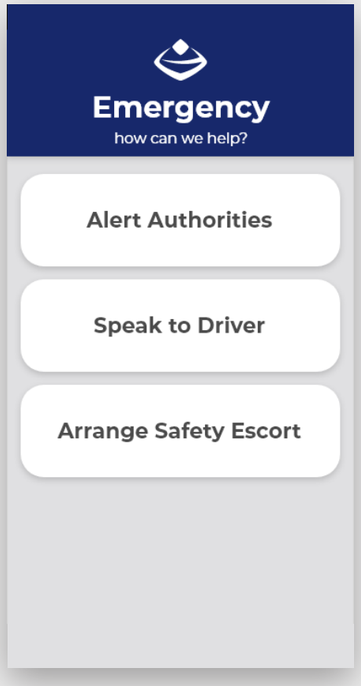
This large display shows the bus number, the occupancy of the bus, and the upcoming destination. Another feature included on this display is the **QR code that leads you to the Row mobile site.** However, this QR code can be found all over the bus as it is included in the signage.

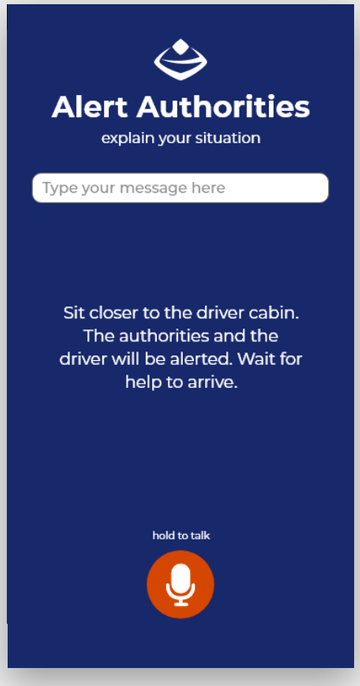
ROW: Mobile Site











On the Row mobile site, the user can do many things. They can **pay their fare**, which then they will be sent an email receipt for proof.

On the site, the passenger can speak to the driver and they can select different reasons to speak with the driver. **The Row mobile site offers a way to communicate with the driver indirectly.** If it is a busy time, the driver must indicate that they cannot be distracted, so the chat option is grayed out. If in an emergency, for example, the passenger is alone with one other person that has been following them on the bus, they can press 'emergency,' and can **discretely type their message or hold to speak into their phone.** This message will be sent to the driver's second display. There, the driver can decide to respond back and carry out further actions.

If the passenger is in an emergency, the **Row site offers a discrete way of calling for help** either through the driver who can keep on eye on them and alert authorities, or by directly alerting authorities or requesting a safety escort.

4. REFLECTIVE DISCUSSION

Row is my design approach to solving the violence and airborne disease related issues that bus drivers face. The process of understanding the problematic situation to researching and designing a solution to address bus driver safety was achieved in a semester. Reflecting back on Autumn 2020, it was an intense semester. I came in knowing that my Industrial Design thesis had to relate to the COVID-19 pandemic, but I still had no idea what I wanted to do.

During the first week of classes, I read an article by Alissa Walker, titled “Coronavirus is not fuel for urbanist fantasies.” Walker discussed how professionals within the field of city planning, many being white and privileged, have viewed the COVID-19 pandemic as time to redesign the urban space. This redesign aims to create safer public spaces during the pandemic, such as outdoor restaurant seating and closing streets to allow for more walking and biking. These ideas come from a place of positivity and urge to create a new and safer “normal.” However, these ideas neglect the needs of people of color and essential workers.

The death rates of the black and Latino population are disproportionately higher than that of Asians and white people. Many people of color also work essential jobs, most of which are not the highest paying. While living in expensive and density populated cities like New York and Los Angeles, issues like homelessness and overcrowding in apartments lead to more people contracting and dying from COVID-19. Similarly, closing streets to promote walking and biking hurts essential workers who need to report to work to keep society running. This article brought to light the needs of people who are often overlooked and underappreciated. After this reading, I realized that I wanted to use design to serve underrepresented people.

Starting off broad, my thesis topic proposal was based on the question, how can we serve essential workers during and after the COVID-19 pandemic? Ideas from designing contact devices to household products that would aid in keeping essential workers’ family members safe began to develop. However, I needed to narrow down my topic in order to begin designing for the problem space.

To learn more about the problematic situation, I researched articles around the topic of essential workers and their experiences during the COVID-19 pandemic. Through the articles, I began to shift my focus to supporting transportation workers, specifically public transit bus drivers.

Prior to the pandemic, bus drivers would experience verbal and physical violence from irate or intoxicated passengers. Fare disputes are the most common reasons for assaults against bus drivers. Spitting, verbal threats, projectiles, and physical assaults are common forms of violence enacted upon bus operators. Race and gender-based violence are also issues that bus drivers face. Simultaneously, veteran bus drivers often experience whole body vibration caused by vibrations and shocks experienced through long hours and long-term operation of the buses. The constant vibrations felt over time can lead to back and leg pain and is detrimental to the operator’s skeletal system.

The onset of the global pandemic brought about more issues within the transit system as transit agencies were slow to provide enough PPE and sanitation to bus drivers and other transit workers. Attempts to tape off the front of the bus, only allowing rear entry, and hanging plastic curtains around the bus drivers were made to protect bus drivers. However, many of these interventions made the bus drivers feel more isolated, unprofessional, and unsafe. Barriers previously installed to protect drivers from violent passengers often leave the drivers feeling cramped and claustrophobic and do not provide enough coverage from COVID-19 droplets.

With the pandemic came even more violence directed towards bus drivers. There have been bus drivers who have been attacked trying to enforce the mask rule and social distancing. The increase in anti-Asian sentiment resulted in more assaults against people of Asian descent and subsequently Asian bus drivers. COVID-19 unveiled many more problems that bus drivers face further proving that it is necessary to support them.

In order to support bus drivers during and after the global pandemic, I set out to interview bus drivers and bus riders to gather insight on their bus experiences. Many bus drivers have experienced violence from passengers; however, they value and appreciate positive interactions with passengers. Through interviews with bus drivers, I realized that in order to design to protect bus drivers, I must not eliminate one of the most rewarding aspects of bus operating, the worthwhile interactions with passengers.

The exploration of the problematic and approach to research with empathy led to the identification of my final objectives. To promote the safety of bus drivers without removing the interaction between the driver and passenger and to design a safe, comfortable, and efficient environment for bus drivers and passengers.

To reach these objectives, I went through the messy discovery phase in the design process. Then my next steps were to begin designing (development phase) and lastly to deliver. Understanding and using design thinking further helped push me into the final direction. It helped me discover the problem and narrow it down after learning and receiving feedback from the stakeholders.

The design and development step in the design process started off with many ideas ranging from a wearable to help bus drivers' health and safety to redesigning the front of the bus. I determined that redesigning the front of the bus was the best approach to protecting bus drivers while allowing operator and passenger interaction. To reach this point, I analyzed my findings from previous research and learned more about buses. I wanted to learn about buses because this is the main environment that bus drivers occupy, and I need to understand buses in order to recognize how the bus environment can protect them. Through my secondary research, I learned about low and high floor buses, wheelbases, types of bus doors, door size correlation with ramps, fares, air suspension, and barriers. This knowledge aided in developing insightful questions for bus drivers I would interview later on. I also toured a bus and learned more about the pain points in newly installed barriers and how they are being disinfected during the pandemic.

Initially, I started designing different barriers to address the issue of violence. However, I found that many barrier designs may protect drivers from violence but may not be adequate at preventing the spread of COVID-19 droplets. Barriers that offer full coverage cannot be fully opened when not in use due to dimension constraints in the front of the bus. Many barriers lock at the fare box or the fare box may be in the way for the barrier to close if the barrier is also designed to section off the front of the bus. I conducted a formative assessment to see what bus drivers and passengers thought about existing barriers and my barrier design. The feedback was helpful and made me realize that a barrier design may not be the best option. So I shifted my focus to the front of the bus.

My final design was a redesign of the bus front that included a system of entry and communication. Row is the next fleet of buses that aims to work towards a future where bus driver injuries and illnesses decrease. The front wheel and front door of a traditional bus is switched to create a separate driver cabin. This prevents the driver from being the first person a passenger sees on the bus. The fare box is removed so in order to ride the bus the passenger must apply for a Row Card. On this card, tickets can be purchased, and money can be added online through the Row mobile site or at kiosks situated at certain bus stops and convenience stores, making it accessible to everyone. To ride the bus, passengers can scan or swipe their bus card or even pay the fare online. This eliminates cash fare payments and fare disputes, which are the most common reasons for violence against bus drivers. In order to maintain passenger and driver interaction, the driver can open a window or the door (if they are comfortable) of their cabin to speak with passengers. Passengers can also communicate with the driver through the Row mobile site and speak to the driver through their phone. The driver's dashboard includes a secondary screen to access cameras, their schedule, and to speak to passengers. This separate cabin also allows the drivers to concentrate when driving during rush hour and the cabin is spacious to encourage the drivers to get up and stretch. Bus drivers will no longer feel cramped and claustrophobic with a barrier directly attached to their seat but will be protected in their own commodious cabin. This redesigned bus front and system protects bus drivers from physical assaults and airborne diseases, while providing forms of interaction between the driver and passenger during the COVID-19 pandemic.

I believe that design helps address problems

thoroughly. Design and the design process are an impactful way of problem solving that prioritizes the needs of the users and aims to develop a solution that will not only address the problem but improve experiences. Design solves problems through understanding the users and the problem space. This empathetic approach carefully considers the needs and desires of the users so designers can design for and with them. Throughout my design process, I concentrated on locating the problem and understanding the users' needs. Being able to receive feedback from my users on my designs furthered showed me their values and needs. I learned a great deal from the bus drivers I interviewed and my secondary research on buses and the problem space. With this, I have also gained a deeper respect for bus drivers and services workers. Gathering all of this information while continuously iterating led to the development of my project, Row.

5. CONCLUSION

This book provides an in-depth view of all of my work this semester. From initial exploration of the problematic situation to the development of a bus. So much has happened in these past few months and being able to see the birth of an idea, watching it grow and become an adult makes me so proud. What makes this project different from all the others is the immense amount of research put and the size of my project.

We spent the majority of this semester conducting research to better understand the problematic situation and then to narrow down on a specific topic. That preliminary research provided a sturdy base of knowledge that allowed us to build on top of it. After the preliminary research, we were on our own to determine what need to be done in order to develop a solution to the problem. In this process, I dove deeper into research focusing on the technical elements of a bus. From there I contacted and interviewed a few bus drivers to understand their driving experiences and what concerns they had. I even met with someone who worked for CABS and got a tour of a bus. This meeting further helped me through the process of designing Row.

I've gone through several tabloid sheets of paper writing and rewriting the features Row would have. Just to end up sketching on top of the writing. A lot of my ideation and form iteration was done on top of my notes, which resulted in very messy sketches that I had to sketch again to make legible. Nevertheless, this process worked, and I was able to convert my sketches into CAD.

Row is the largest model I have created in SolidWorks. Previously, I modeled a power drill to scale and that was difficult because it had to be accurate. I did have creative freedom and wriggle room to model Row, but a bus is intense. A bus design cannot be done in the amount of time I had. So I opted to redesign the front of a bus. I did not model any seats or rails and the details in the dashboard. I am very proud of what I was able to do in 2 weeks, which is the amount of time to model Row. Then I was able to create a few Keyshot renderings that brought my concept bus to life.

The design of Row allows for it to protect bus drivers by creating a separate driver cabin for them. By switching the placement of the front door and front wheels, the driver now sits higher up, and they are no longer the first point of contact upon entering the bus. With the cabin door behind the driver, the driver will not have to worry about reflections in the glass door obstructing their view. At the same time, they can easily peer into the passenger section. The glass door can protect them from violent passengers or angry passengers that often threaten, spit, and throw drinks at the driver.

Another part of my thesis was the mobile site and secondary display designs. I wanted to encourage passenger and driver interactions and especially with COVID-19, interactions are tricky and can be dangerous for both parties. So I thought a good way to promote interaction is through virtual chatting. Passengers can speak or message the bus driver through the Row mobile site, which then gets transferred to the bus driver's secondary display. There the message is played out loud and the driver can respond. This allows for communication to continue and gives bus drivers the choice to speak to passengers. Not all bus drivers enjoy interacting with passengers and there are times where the driver cannot be distracted. So the driver has the option to disable the chatting feature and only allowing emergency or necessary conversations to carry out.

Now my thesis is complete. However, there is still much to do. My next steps are to design the passenger seating and the driver dashboard, potentially adding a heads-up display. I know a project is never really finished. I have to be the one to draw the finish line at times, but I believe adding in the rest of the bus will truly complete it.

THANK YOU